DELAWARE RIVER BASIN
TAYLORTOWN CREEK, PIKE COUNTY

PENNSYLVANIA

LAKE GREELEY DAM

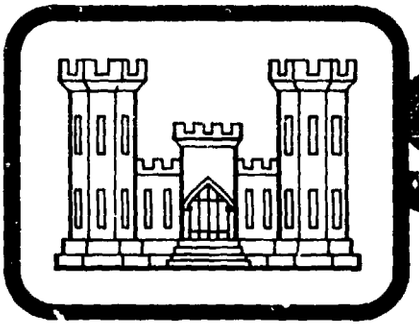
NDI I.D. NO. PA-00752
PENNDER I.D. NO. 52-20

LEVEL II

LOHIKAN CAMPS

DACW31-81-C-0015

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



PREPARED FOR

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

PREPARED BY

GAI CONSULTANTS, INC.
570 BEATTY ROAD
MONROEVILLE, PENNSYLVANIA 15146

SEPTEMBER 1981

411002

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the Spillway Design Flood is based on the estimated Probable Maximum Flood (greatest reasonably possible storm runoff) for the region, or fractions thereof. The Spillway Design Flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition, and the downstream damage potential.

Breach analyses are performed, when necessary, to provide data to assess the potential for downstream damage and possible loss of life. The results are based on specific theoretical scenarios peculiar to the analysis of a particular dam and are not applicable to other related studies such as those conducted under the Federal Flood Insurance Program.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

ABSTRACT

Lake Greeley Dam: NDI I. D. No. PA-00752

Owner:	Lohikan Camps
State Located:	Pennsylvania (PennDER I. D. No. 52-20)
County Located:	Pike
Stream:	Taylortown Creek
Inspection Date:	21 May 1981
Inspection Team:	GAI Consultants, Inc. 570 Beatty Road Monroeville, Pennsylvania 15146

Based on a visual inspection, operational history, and hydrologic and hydraulic analysis, the dam is considered to be in fair condition.

The size classification of the facility is small and its hazard classification is considered to be high. In accordance with the recommended guidelines, the Spillway Design Flood (SDF) for the facility ranges between the 1/2 PMF (Probable Maximum Flood) and the PMF. Since the facility is classified near the upper bounds of the small category with regard to available storage capacity, the SDF is considered to be the PMF. Results of the hydrologic and hydraulic analysis indicate that under existing conditions the facility will pass and/or store only about 17 percent of the PMF prior to embankment overtopping at the low area adjacent the left abutment. If the low area were regraded to the design top of dam, the spillway system would then pass about 28 percent of the PMF prior to embankment overtopping. Under existing conditions, spillway discharges are controlled by the existence of a township-owned roadway embankment and culvert that is situated about 100 feet downstream of the spillway weir. Breach analyses indicate that failure of Lake Greeley Dam under less than 1/2 PMF conditions would probably not lead to increased damage or potential for loss of life downstream, due to the presence of the roadway embankment. Thus, based on the screening criteria provided in the recommended guidelines, the spillway is considered to be inadequate, but not seriously inadequate. It is noted that if the downstream roadway and culvert were not present, Lake Greeley Dam would still not be capable of passing the 1/2 PMF event without overtopping, and the potential failure of the dam due to overtopping could in this case lead to increased property damage and possibly loss of life in the downstream regions (see Section 5.5.b).

Lake Greeley Dam: NDI I.D. No. PA-00752

It is recommended that the owner immediately:

a. Develop a formal emergency warning system to notify downstream residents should hazardous embankment conditions develop. Included should be provisions for around-the-clock surveillance of the facility during periods of unusually heavy precipitation.

b. Regrade the embankment crest to the top of spillway sidewalls at elevation 1160.0 feet, infilling any low areas and extending the left embankment end upstream until the crest meets its corresponding natural ground contour.

c. Clear all excess vegetation from the embankment crest and slopes on a regular routine basis in order to maintain an unobstructed view of the facility. This operation should include the removal of the small pine trees that were recently planted along the left embankment crest, in order to eliminate the possibility of potentially destructive root growth.

d. Repair the cracking and deterioration observed along both spillway sidewalls. In addition, remove the overgrowth from the discharge channel between the spillway weir and downstream roadway embankment.

e. Provide additional rock slope protection to the unprotected areas observed along the upstream face of the left embankment section.

f. Develop formal manuals of operation and maintenance to ensure the future proper care and operation of the facility.

GAI Consultants, Inc.

Bernard M. Mihalcin

Bernard M. Mihalcin, P.E.

Date 11 Sept. 1981

Approved by:

James W. Peck
Colonel, Corps of Engineers
Commander and District Engineer

Date 18 Sep 1981

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
BERNARD M. MIHALCIN
ENGINEER
20371-E

OVERVIEW PHOTOGRAPH

TABLE OF CONTENTS

TABLE OF CONTENTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
LAKE GREELEY DAM
NDI NO. PA-00752, PENNDER No. 52-20

SECTION 1
GENERAL INFORMATION

1.0 Authority.

The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

1.1 Purpose.

The purpose is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Lake Greeley Dam is a 10-foot high earth embankment approximately 308 feet long, including spillway. The facility is constructed with an uncontrolled, rectangular shaped, concrete spillway with an ogee-type weir located near the center of the embankment. The length of the spillway crest is 103 feet. Drawdown is provided by a 6-inch diameter cast iron pipe at the base of the spillway, situated about 31 feet right of the left sidewall, and by a stop log gate opening cut through the spillway ogee itself, situated about 61 feet right of the left sidewall. Flows through the conduit are manually controlled at its discharge end by a 6-inch diameter gate valve.

b. Location. Lake Greeley Dam is located across Taylortown Creek in Lackawaxen Township, Pike County, Pennsylvania. The facility is situated about 1-mile northwest of the junction of U. S. Route 6 and Pennsylvania Route 434 and about 2 miles southwest of the community of Greeley, Pennsylvania. The dam, reservoir and watershed are contained within the Rowland, Pennsylvania, 7.5 minute U.S.G.S. topographic quadrangle (see Figure 1, Appendix E). The coordinates of the dam are N41°24.9' and W75°1.1'.

c. Size Classification. Small (10 feet high, 878 acre-feet storage capacity at top of dam elevation 1160.0 feet).

d. Hazard Classification. High (see Section 3.1.e).

e. Ownership. Lohikan Camps
Camp Greeley
P. O. Box 234
Kenilworth, New Jersey 07033
Attn: Mark Buynak

f. Purpose. Recreation.

g. Historical Data. PennDER files contain historical data pertaining to Lake Greeley Dam dating back to 1916. At that time the dam was owned by Lafayette McKean, who operated it as a water supply for his saw mill facility. The dam consisted of a stone and earthfill structure, 10 feet in height and about 200 feet in length. The crest was about 12 feet wide and served as a public highway. From 1916 through 1930 numerous complaints are on record pertaining to the safety and operation of the dam.

In 1931 ownership of the dam was transferred to a Carl A. Hummel, who retained ownership until his death in 1958. During this period several attempts were made to coordinate maintenance and necessary repairs to the dam and public highway. Eventually in 1956, as no cooperative agreement could be reached between the dam owner and township officials, the dam and township roads were separated. Correspondence indicates that the township first replaced the crest roadway with a new embankment and concrete arch culvert situated immediately downstream of the dam. Shortly thereafter, the dam was totally reconstructed into its present form.

After the death of Mr. Hummel, the facility was owned by an Andrew B. Ulichney until 1968 when it became the property of Lohikan Camps (Michael F. Buynak, Partner).

1.3 Pertinent Data.

a. Drainage Area (square miles). 7.3

b. Discharge at Dam Site.

Discharge Capacity of Outlet Conduit - Discharge curves are not available.

Discharge Capacity of Spillway at Base of Embankment Break (elevation 1157.9 feet) ≅ 1730 cfs (see Appendix D, Sheet 22).

Discharge Capacity of Spillway at Maximum Pool (elevation 1160.0 feet) ≅ 2,940 cfs (see Appendix D, Sheet 23).

c. Elevations (feet above mean sea level). The following elevations were obtained from available drawings and through field measurements based on the elevation of normal pool at 1155.0 feet as indicated in Figure 1, Appendix E.

Top of Dam	1160.0 (design).
Top of Spillway Sidewalls	1160.0 (field).
Top of Dam at Embankment Break	1160.6 (field; see Section 2.1.b.1 for explanation).
Base of Embankment Break	1157.9 (field).
Maximum Design Pool	Not known.
Maximum Pool of Record	Not known.
Normal Pool	1155.0 (assumed datum).
Spillway Crest	1155.0
Upstream Inlet Invert	Not known.
Downstream Outlet Invert	1149.8 (design). 1150.1 (field).
Streambed at Downstream Toe of Spillway Weir	1150 (estimate).

d. Reservoir Length (feet).

Top of Dam	6350
Base of Embankment Break	6000
Normal Pool	5550

e. Storage (acre-feet).

Top of Dam	878
Base of Embankment Break	574
Normal Pool	290

f. Reservoir Surface (areas).

Top of Dam	165
Base of Embankment Break	126
Normal Pool	72

g. Dam.

Type	Earth.
Length	205 feet (excluding spillway).
Height	10 feet (field measured; top of spillway sidewalls to downstream outlet invert. Embankment break not considered).
Top Width	8 feet.
Upstream Slope	2H:1V (design). varies; 2H:1V to 1.5H:1V (field).

	Downstream Slope	2H:1V (design). 2.5H:1V (field).
	Zoning	None indicated.
	Impervious Core	None indicated.
	Cutoff	None indicated.
	Grout Curtain	None indicated.
h.	Diversion Canal and Regulating Tunnels.	None.
i.	Spillway.	
	Type	Uncontrolled, rectangular shaped, concrete channel with an ogee type weir located near the center of the embankment.
	Crest Elevation	1155.0
	Crest Length	103 feet.
j.	Outlet Conduit.	
	Type	Six inch diameter cast iron pipe located at the downstream base of the spillway weir about 31 feet right of the left sidewall.
	Length	Not known.
	Closure and Regulating Facilities	Six inch diameter gate valve located at the discharge end of the conduit.
	Access	Control mechanism is manually operated at the base of the spillway weir; however, it is accessible only during periods of low or no spillway discharge.

SECTION 2
ENGINEERING DATA

2.1 Design.

a. Design Data Availability and Sources. No formal design reports or calculations are available concerning any aspect of this facility. PennDER files contain a set of two design drawings, dated April 1956, by Michael A Policelli, registered engineer, from Roseto, Pennsylvania. These drawings have been included in Appendix E of this report (see Figures 3 and 4). Also included in the files are extensive correspondence and memoranda dating back to 1914, along with about 65 dated photographs. A construction permit application report, issued by the state and dated 1957, is available and contains a brief description of some of the various design aspects of the present facility.

b. Design Features.

1. Embankment. Design features of the embankment are presented in Figures 3 and 4. As indicated, the present structure was built directly atop an existing dike. The structure was designed with 2H:1V upstream and downstream slopes and an 8-foot wide crest. Field measurements indicate slight variations from the design to the as-built structure (see Section 1.3.g). The upstream embankment face was to be covered by a 12-inch layer of riprap while the downstream embankment face and crest were to be seeded.

PennDER files reveal years of non-cooperation between the various owners of Lake Greeley Dam and the supervisors of Lackawaxen Township who maintain the public road presently located immediately downstream of the dam. Prior to construction of the present facility, the road ran across the embankment crest from abutment to abutment, spanning the spillway via a small wooden bridge. Responsibility for various maintenance deficiencies cited by state inspectors was a matter of continuous disagreement between the two parties. Finally, between 1956 and 1958, both the township and dam owner reconstructed their facilities independent of each other. As indicated in the "General Plan" depicted in Figure 3, the left end of the embankment was to form a portion of the road; however, due to a lack of communication and/or cooperation, the township completed the road prior to completion of the dam, leaving it solely up to the dam owner as to what action to take in regards to the left end of this embankment. The result was the curved embankment section shown in Photographs 1 and 2. Compounding these problems, the dam owner prematurely ceased construction, leaving the left end of the embankment short of the natural contour to which it should connect. The result is the abrupt termination ("break") of the embankment shown in Photograph 3. The condition provides an obvious low area that effectively reduces spillway capacity by reducing available freeboard by approximately 2 feet.

The available construction permit application report, dated 1957 and specifications, dated 1956, indicate the dam is constructed with a clay filled cutoff trench, although no such trench is shown in the figures. Furthermore, the report states that the material would be placed in 6-inch layers and compacted by a sheepsfoot roller.

2. Appurtenant Structures.

a) Spillway. Design features of the spillway are presented in Figures 3 and 4. As indicated, the spillway is an uncontrolled, rectangular shaped, concrete channel with a concrete-gravity, ogee-type weir. The design crest length is 104 feet, although field measurements indicate it to be 103 feet. This, coupled with 5 feet of available freeboard, gives the spillway a theoretical discharge capacity of about 4,330 cfs. (Note: The abrupt termination of the embankment left end and the highway culvert immediately downstream of the spillway both serve to reduce overall spillway capacity. See Section 5.3). A stop log opening for the purpose of reservoir drawdown is cut through the ogee about 61 feet right of the left sidewall. The opening is 5 feet wide and extends from the ogee crest to its base. Wood planks currently form the stop logs that cover the opening.

b) Outlet Conduit. The outlet conduit is depicted in both Figures 3 and 4. As indicated, the outlet conduit consists of a 6-inch diameter cast iron pipe located at the base of the ogee spillway section about 31 feet right of the left sidewall. Flows through the conduit are controlled by means of a manually operated 6-inch diameter gate valve situated at its discharge end.

c. Specific Design Data and Criteria. No specific design data or information relative to design procedures are available.

2.2 Construction Records.

No formal construction records are available for this facility. PennDER files contain miscellaneous memoranda and correspondence accumulated during the construction period, along with several dated photographs of the facility taken soon after its completion.

2.3 Operational Records.

There are no existing records of the day-to-day operation of the facility.

2.4 Other Investigations.

Formal state inspection reports are contained in PennDER files for the years 1919, 1929, 1933, 1938, 1941, 1948, 1956 and 1964.

Aside from the 1964 inspection, no other formal investigations have been performed on the present facility.

2.5 Evaluation.

The available data are considered sufficient to make a reasonable Phase I evaluation of the facility.

SECTION 3
VISUAL INSPECTION

3.1 Observations.

a. General. The general appearance of the facility suggests the dam and its appurtenances are in fair condition.

b. Embankment. Observations made during the visual inspection indicate the embankment is in fair condition. The embankment section to the right of the spillway is heavily overgrown with brush and small trees (4 inches in diameter or less). Maintenance of this area appears non-existent (see Photograph 4). The embankment section to the left of the spillway is well maintained relative to the right embankment section; however, several deficiencies were noted. For the most part, the left embankment section is grass covered and appears to be mowed regularly (see Photograph 1). Nevertheless, 3 small trees were observed growing out of the upstream embankment face. In addition, 6 small pines (≅ 2 feet high) have been planted at regular intervals along the left embankment crest (see Photographs 1 and 2). The inspection team observed several bare areas along the upstream face of the left section, the result of displaced riprap. Some minor erosion has resulted, lending a somewhat irregular appearance to the upstream face. No evidence of animal burrows, seepage through the downstream embankment face or excessive settlement was observed.

c. Appurtenant Structures.

1. Spillway. The visual inspection revealed the spillway is in good condition. Both concrete sidewalls exhibit some vertical cracking and noticeable deterioration along the horizontal joint at pool level (see Photograph 5). The discharge channel between the spillway and downstream highway culvert is rock lined and heavily overgrown at present (see Photographs 6 and 7).

2. Outlet Conduit.

The outlet conduit was partially submerged by spillway discharge on the day of the inspection and was not operated in presence of the inspection team. No evidence of extraordinary deterioration was observed.

d. Reservoir Area. The general area surrounding the reservoir is composed of gentle to moderate, wooded slopes along the southern shore of the lake and moderate to steep, wooded slopes along the northern shore. No signs of slope distress were observed.

e. Downstream Channel. Discharges from Lake Greeley Dam pass through the culvert beneath the township road located immediately downstream and are channeled into Taylortown Creek (see Photograph 8). The stream is set in a narrow, wooded valley with

steep confining slopes and flows about 6,600 feet prior to discharging into Sylvania Lake. Sylvania Lake is a 44 acre-foot (maximum storage at top of dam) reservoir impounded by a small embankment about 8 feet high and 140 feet long (see Appendix D, Sheet 17). The spillway consists of an uncontrolled, rectangular shaped, concrete channel with an ogee-type weir. The maximum spillway discharge capacity is approximately 400 cfs, based on a crest length of 40 feet and 2.0 feet of freeboard (see Appendix D, Summary Input/Output Sheets, Sheet J).

Beyond Sylvania Lake, Taylortown Creek becomes Balliard Creek. Balliard Creek flows approximately 2.4 miles before discharging into Shohola Creek. Six or seven inhabited structures are situated along this reach sufficiently near the streambed to possibly be affected by the floodwave resulting from a sudden breach of Lake Greeley Dam. The structures are located at Sections 1, 2, 3 and 4 as indicated in Figure 1. It is estimated that as many as 30 lives could be affected by such a breach event. Consequently, the hazard classification for this facility is considered to be high.

3.2 Evaluation.

The overall condition of the facility based on visual observations is considered to be fair. Remedial measures should be implemented to: 1) repair the deterioration associated with the spillway sidewalls; 2) remove excess vegetation from both the left and right embankment sections and the area between the spillway and downstream highway culvert; and 3) cover the unprotected areas along upstream face of the left embankment section with additional riprap slope protection.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Normal Operating Procedure.

Lake Greeley Dam is essentially a self-regulating facility. That is, excess inflows are automatically discharged through the uncontrolled spillway and directed downstream. Typically, the outlet conduit is closed and reportedly has not been opened for several years. The conduit was not operated in the presence of the inspection team. No formal operations manual is available.

4.2 Maintenance of Dam.

The owner reportedly maintains the facility on an as-needed, unscheduled basis. Conditions observed by the inspection team indicate, however, a general lack of adequate maintenance. No formal maintenance program has been established and no formal manuals are available.

4.3 Maintenance of Operating Facilities.

See Section 4.2 above.

4.4 Warning System.

No formal warning system is presently in effect.

4.5 Evaluation.

The general appearance of the facility suggests a lack of adequate maintenance. No formal maintenance or operations manuals are available, but, are recommended to ensure the future proper care and operation of the facility. In addition, formal warning system procedures should be incorporated into these manuals to provide for the protection of downstream residents should hazardous embankment conditions develop.

SECTION 5
HYDROLOGIC/HYDRAULIC EVALUATION

5.1 Design Data.

No formal design reports or calculations are available for this facility. According to information contained in PennDER files, the spillway at Lake Greeley Dam was sized for a design discharge capacity of 4,500 cfs. The structure was to be 104 feet long with 5 feet of available freeboard. At that time, the design capacity was considered adequate in accordance with the criteria established in the Pennsylvania "C" Curve based on a reported drainage area of 6.45 square miles. (Note: The spillway was actually built with a 103-foot long crest and 5 feet of available freeboard from spillway crest to top of spillway sidewalls. Thus, the theoretical spillway capacity more closely approximates 4,330 cfs. Furthermore, the drainage area, as measured for use in this analysis, is about 7.3 square miles. Based on the actual size of the drainage area, the "C" Curve criteria would have required a spillway capacity of about 6,500 cfs).

5.2 Experience Data.

Daily records of reservoir levels and/or spillway discharges are not available. Previous facilities at this site had a history of overtopping which occasionally resulted in downstream damage. Since the completion of the present facility in 1958, no such incidents have been recorded. The general appearance of the facility suggests adequate recent past performance.

5.3 Visual Observations.

On the date of inspection, conditions were observed that could potentially hamper the spillway from functioning as designed. Specifically, the culvert beneath the roadway immediately downstream of the dam is insufficiently sized to pass the maximum expected spillway flows, and the roadway embankment is actually higher than the dam for much of its length. Thus, high tailwater conditions will be created and the discharge efficiency of the spillway will be reduced significantly under high discharges (see Appendix D, Sheets 21 and 22). In addition, the abrupt termination or break in the embankment at its left end reduces the available freeboard by about 2 feet. Consequently, the discharge capacity of the spillway is further reduced, and embankment overtopping will occur under conditions less severe than those for which the facility was designed.

5.4 Method of Analysis.

The facility has been analyzed in accordance with the procedures and guidelines established by the U.S. Army, Corps of Engineers, Baltimore District, for Phase I hydrologic and hydraulic evaluations. The analysis has been performed utilizing a modified version of the HEC-1 program developed by the U.S. Army, Corps of Engineers, Hydrologic Engineering Center, Davis, California. Analytical capabilities of the program are briefly outlined in the preface contained in Appendix D.

5.5 Summary of Analysis.

a. Spillway Design Flood (SDF). In accordance with procedures and guidelines contained in the National Guidelines for Safety Inspection of Dams for Phase I Investigations, the Spillway Design Flood (SDF) for Lake Greeley Dam ranges between the 1/2 PMF (Probable Maximum Flood) and the PMF. This classification is based on the relative size of the dam (small), and the potential hazard of dam failure to downstream developments (high). Since the facility is classified near the upper bounds of the small category (878 acre-feet storage at top of dam, neglecting the abrupt termination at the left end of the embankment), its SDF is considered to be the PMF.

b. Results of Analysis. Lake Greeley Dam was evaluated under normal operating conditions. That is, the reservoir was initially at its normal pool or spillway crest elevation of 1155.0 feet, with the spillway weir discharging freely. The outlet conduit was assumed to be closed in this analysis, since the flow capacity of the conduit is not such that it would significantly increase the total discharge capabilities of the dam and reservoir. The spillway consists of an uncontrolled, rectangular shaped, concrete channel with a concrete, ogee-type weir. All pertinent engineering calculations relative to the evaluation of Lake Greeley Dam are provided in Appendix D.

Overtopping analysis (using the modified HEC-1 computer program) indicated that the discharge/storage capacity of Lake Greeley Dam can accommodate only about 17 percent of the PMF prior to overtopping at the low area or break in the embankment near its left end. It was also found that if the embankment crest were regraded to the elevation of the top of the spillway sidewalls (elevation 1160.0), the facility could then pass approximately 28 percent of the PMF prior to embankment overtopping (Appendix D, Sheet 23). These percentages were based on spillway capacities in which the effects of tailwater, resulting from the backup of water behind the downstream culvert and roadway embankment, were taken into account. It was determined that if the roadway and culvert were not present, the facility could pass approximately 18 percent of the PMF before overtopping the low area at the left end of the embankment and about 41 percent of the PMF if the embankment were regraded to elevation 1160.0 (Appendix D, Sheet 23).

As Lake Greeley Dam cannot safely accommodate floods of at least 1/2 PMF magnitude, the possibility of embankment failure under floods of 1/2 PMF intensity or less was investigated (in accordance with Corps directive ETL-1110-2-234). The modified HEC-1 computer program was used for the breaching analysis, with the major concern being the effects of the various breach discharges on increasing downstream water surface elevations above those to be expected if breaching did not occur.

Several schemes were developed to model the potential failure of Lake Greeley Dam under existing conditions. It was concluded that if failure were to occur, it would be over an extended period of time, due to the presence of the roadway embankment located immediately downstream of the dam and the tailwater associated with it. Therefore, the breach times (total time for breach section to reach its final dimensions) ranged from 4 to 12 hours, essentially modeling the potential failure of the dam and the roadway embankment simultaneously. It was also assumed that failure would occur only in the embankment to the left of the spillway, due to the configuration of the dam in relation to the roadway embankment, and since the low area in the embankment was at its left end. The maximum probable failure section was used in this analysis (see Appendix D, Sheet 24).

The breach models were analyzed under 0.20 PMF, 0.30 PMF, and 0.50 PMF base flow conditions. The peak outflows resulting from the 4-hour breaches were 2,370 cfs, 3,350 cfs, and 5,890 cfs, respectively, compared to the non-breach peak outflows of 2,050 cfs, 3,120 cfs, and 5,280 cfs, respectively (Appendix D, Summary Input/Output Sheets, Sheets I and J). The discharge hydrographs were routed through Sylvania Lake Dam, located approximately 6,600 feet downstream from Lake Greeley Dam (see Figure 1). The possibility of failure of this facility due to overtopping was not considered here. The discharges were then routed through the potential hazard centers, Sections 1-4 (see Figure 1). In all cases, the increases in the downstream water levels resulting from the breaches were not significant, such that increased potential for loss of life or property damage was not likely (Appendix D, Sheet 25).

Finally, a potential failure of the dam was analyzed in which the downstream roadway embankment was not considered to be present. It was found here that if the dam were to fail somewhat rapidly (breach time $\leq$ 1-hour), the increases in the downstream water levels above the non-breach levels would be significant (Appendix D, Sheet 26). Therefore, if the downstream roadway embankment were not present, the failure of Lake Greeley Dam would most likely lead to increased property damage and possibly loss of life in the downstream regions.

5.6 Spillway Adequacy.

As presented previously, under existing conditions, Lake Greeley Dam can accomodate only about 17 percent of the PMF prior

to embankment overtopping. Should an event of magnitude greater than this occur, the dam would be overtopped and could possibly fail. However, since the failure of this dam would probably not lead to significant increased property damage or loss of life at existing residences, its spillway is considered to be inadequate, but not seriously inadequate.

SECTION 6
EVALUATION OF STRUCTURAL INTEGRITY

6.1 Visual Observations.

a. Embankment. Based on visual observations, the structural condition of the embankment is considered to be fair. The major deficiency encountered by the inspection team concerns the abrupt termination of the left end of the embankment. Under conditions of rising pool levels, the low area between the embankment and left abutment would be overtopped first. Since there are no specific provisions at the left end of the embankment or along the downstream embankment face for protection against erosion, it must be assumed that the structure is especially vulnerable to damage in this area. The results of breach analyses discussed in Section 5.5.b indicate, however, that failure of the embankment, in general, will not increase the potential for property damage and/or loss of life downstream due to the presence of the roadway embankment situated just beyond the downstream dam toe. The condition at the embankment left end serves to increase the damage potential of the roadway embankment. Thus, prompt repair and elimination of this condition is considered immediately necessary and can be achieved by extending the embankment upstream until it abuts the natural ground contour at top of spillway sidewall elevation 1160.0 feet. It is noted that this remedial measure does not eliminate the possibility for embankment overtopping or damage to either the dam or roadway embankment, but, will alleviate a highly unusual condition and reduce the damaging potential.

Other deficiencies encountered can be attributed, for the most part, to a lack of adequate maintenance. The overgrowth observed along the right embankment section and, to a much lesser degree, along the left embankment section is considered a significant deficiency requiring remedial attention. The root systems of trees may offer a course for possible piping through the embankment. Excess vegetation also obscures clear view of the downstream toe, which may become critical in the event of an embankment emergency.

b. Appurtenant Structures.

1. Spillway. The spillway is considered to be in good condition. Cracks and noticeable deterioration observed along the spillway sidewalls should be repaired as part of regular routine maintenance.

2. Outlet Conduit. The outlet conduit was not operated in the presence of the inspection team; however, no signs of significant deterioration were observed.

6.2 Design and Construction Techniques.

No specific design data and little construction information pertaining to the facility are available.

6.3 Past Performance.

There are no records documenting any events during which the present facility has not adequately functioned.

6.4 Seismic Stability.

The dam is located in Seismic Zone No. 1 and may be subject to minor earthquake induced dynamic forces. As the facility appears to be well constructed and sufficiently stable, it is believed that it can withstand the expected dynamic forces; however, no calculations and/or investigations were performed to confirm this opinion.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS FOR REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety. The results of this investigation indicate the facility is in fair condition.

The size classification of the facility is small and its hazard classification is considered to be high. In accordance with the recommended guidelines, the Spillway Design Flood (SDF) for the facility ranges between the 1/2 PMF (Probable Maximum Flood) and the PMF. Since the facility is classified near the upper bounds of the small category with regard to available storage capacity, the SDF is considered to be the PMF. Results of the hydrologic and hydraulic analysis indicate that under existing conditions the facility will pass and/or store only about 17 percent of the PMF prior to embankment overtopping at the low area adjacent the left abutment. If the low area were regraded to the design top of dam, the spillway system would then pass about 28 percent of the PMF prior to embankment overtopping. Under existing conditions, spillway discharges are controlled by the existence of a township-owned roadway embankment and culvert that is situated about 100 feet downstream of the spillway weir. Breach analyses indicate that failure of Lake Greeley Dam under less than 1/2 PMF conditions would probably not lead to increased damage or potential for loss of life downstream, due to the presence of the roadway embankment. Thus, based on the screening criteria provided in the recommended guidelines, the spillway is considered to be inadequate, but not seriously inadequate. It is noted that if the downstream roadway and culvert were not present, Lake Greeley Dam would still not be capable of passing the 1/2 PMF event without overtopping, and the potential failure of the dam due to overtopping could in this case lead to increased property damage and possibly loss of life in the downstream regions (see Section 5.5.b).

b. Adequacy of Information. The available data are considered sufficient to make a reasonable Phase I assessment of the facility.

c. Urgency. The recommendations listed below should be implemented immediately.

d. Necessity for Additional Investigations. No additional investigations are deemed necessary at this time.

7.2 Recommendations/Remedial Measures.

It is recommended that the owner immediately:

a. Develop a formal emergency warning system to notify downstream residents should hazardous embankment conditions develop.

Included in this should be provisions for around-the-clock surveillance of the facility during periods of unusually heavy precipitation.

b. Regrade the embankment crest to the top of spillway sidewalls at elevation 1160.0 feet, infilling any low areas and extending the left embankment end upstream until the crest meets its corresponding natural contour.

c. Clear all excess vegetation from the embankment crest and slopes on a regular routine basis in order to maintain an unobstructed view of the facility. This operation should include the removal of the small pine trees that were recently planted along the left embankment crest, in order to eliminate the possibility of potentially destructive root growth.

d. Repair the cracking and minor deterioration observed along both the spillway sidewalls. In addition, remove the overgrowth from the discharge channel between the spillway weir and downstream roadway embankment.

e. Provide additional rock slope protection to the unprotected areas observed along the upstream face of the left embankment section.

f. Develop formal manuals of operation and maintenance to ensure the future proper care and operation of the facility.

APPENDIX A

VISUAL INSPECTION CHECKLIST AND FIELD SKETCHES

CHECK LIST
VISUAL INSPECTION
PHASE 1

NAME OF DAM Lake Greeley Dam STATE Pennsylvania COUNTY Pike

NDI # PA — 00752 PENNDER # 52-[illegible]0

TYPE OF DAM Earth SIZE Small HAZARD CATEGORY High

DATE(S) INSPECTION 21 May 1981 WEATHER Clear TEMPERATURE 50° @ 8:00 a.m.

POOL ELEVATION AT TIME OF INSPECTION 1155.2 feet M.S.L.

TAILWATER AT TIME OF INSPECTION N/A M.S.L.

INSPECTION PERSONNEL	OWNER REPRESENTATIVES	*OTHERS*
B. M. Mihalcin	None	
D. J. Spaeder		
D. L. Bonk		

RECORDED BY B. M. Mihalcin

EMBANKMENT

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00752
SURFACE CRACKS	None observed.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed.
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Upstream face of left embankment section is irregular and appears somewhat eroded.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Horizontal - curved embankment. Vertical - see "Profile of Embankment Crest from Field Survey", Appendix A.
RIPRAP FAILURES	Riprap is composed of hard, well graded sandstone boulders and rock fragments. Riprap along the upstream face of the left embankment section appears displaced in some areas.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Junctions of embankment - right abutment, spillway and dam are in good condition. Left embankment section suddenly stops at its extreme left end and does not extend into the left abutment. Obvious low area.

EMBANKMENT

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA- 00752
DAMP AREAS IRREGULAR VEGETATION (LUSH OR DEAD PLANTS)	None observed.
ANY NOTICEABLE SEEPAGE	None observed.
STAFF GAGE AND RECORDER	None.
DRAINS	None observed.
MISCELLANEOUS (vegetation)	Right embankment section is heavily overgrown with trees up to 12 inches in diameter. Left embankment section appears to be regularly maintained; however, six small spruce trees are planted along its crest. Many stumps are evident along the downstream embankment face. Some of the stumps are sprouting new growth.

OUTLET WORKS

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00752
INTAKE STRUCTURE	Six inch diameter cast iron pipe located about 31 feet right of the left spillway sidewall along the downstream base of the ogee section. Intake submerged and not observed. Five foot wide stop log opening cut through the ogee section about 61 feet right of the left spillway sidewall.
OUTLET CONDUIT (CRACKING AND SPALLING OF CONCRETE SURFACES)	Not observed.
OUTLET STRUCTURE	Six inch diameter gate valve located at the discharge end of the outlet conduit at the downstream base of the spillway weir.
OUTLET CHANNEL	Discharges into spillway channel.
GATE(S) AND OPERATIONAL EQUIPMENT	Gate valve partially submerged on day of inspection. Not operated in the presence of the inspection team.

EMERGENCY SPILLWAY

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00752
TYPE AND CONDITION	Uncontrolled, rectangular shaped, concrete chute channel with an ogee shaped, concrete weir. Good condition.
APPROACH CHANNEL	Rock lined forebay area. Several stumps and logs (floating debris) evident near right sidewall.
SPILLWAY CHANNEL AND SIDEWALLS	Left sidewall exhibits two vertical cracks while the right sidewall exhibits one. Should be sealed. Both sidewalls exhibit minor deterioration along the horizontal joint at pool level, but especially at the right sidewall. Should be repaired.
STILLING BASIN PLUNGE POOL	None.
DISCHARGE CHANNEL	Discharges into a rock lined channel and through a large, concrete, arched highway culvert located immediately downstream. Many large trees inhabit the channel between the spillway and downstream culvert.
BRIDGE AND PIERS EMERGENCY GATES	None.

SERVICE SPILLWAY

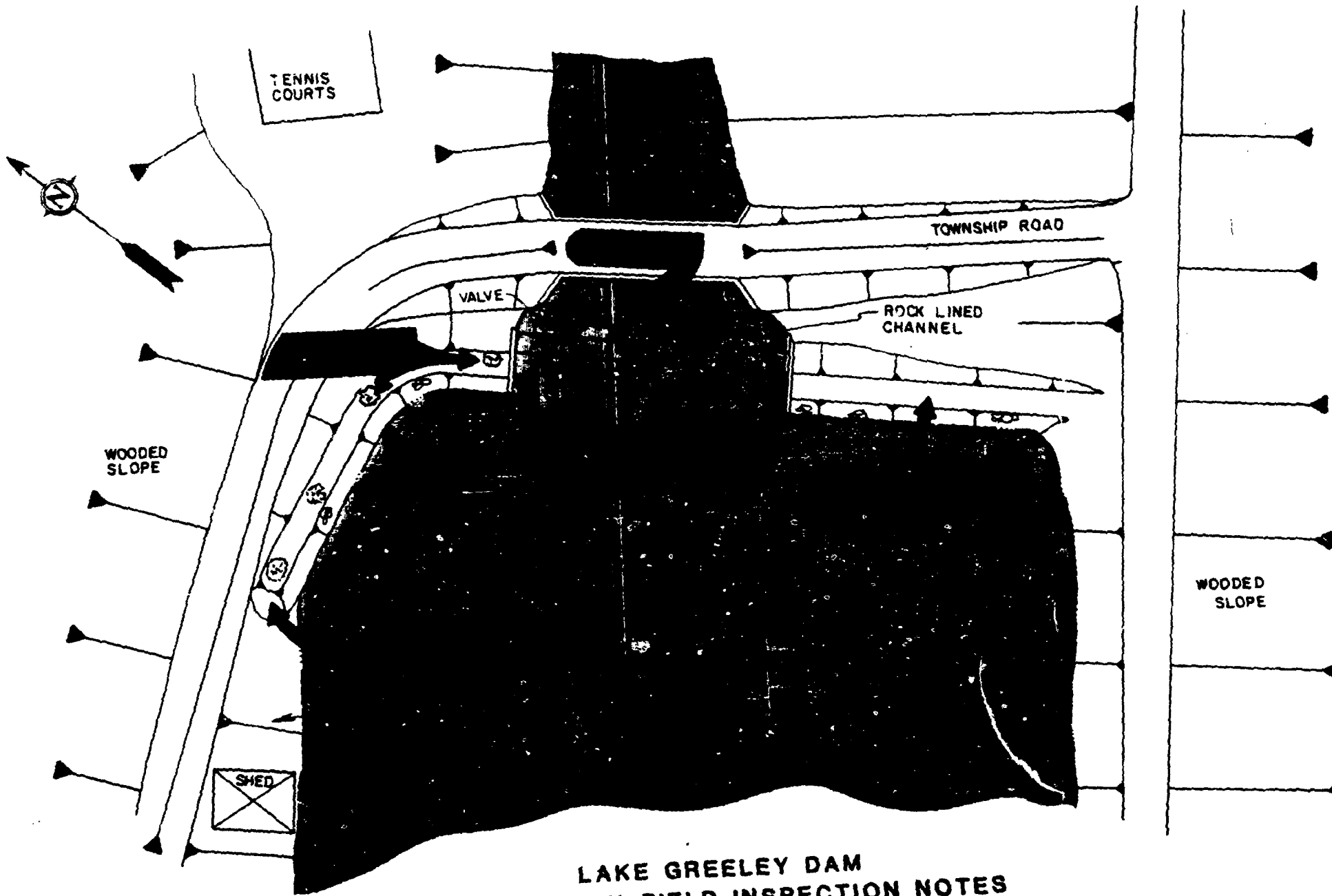
ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00752
TYPE AND CONDITION	N/A.
APPROACH CHANNEL	N/A.
OUTLET STRUCTURE	N/A.
DISCHARGE CHANNEL	N/A.

INSTRUMENTATION

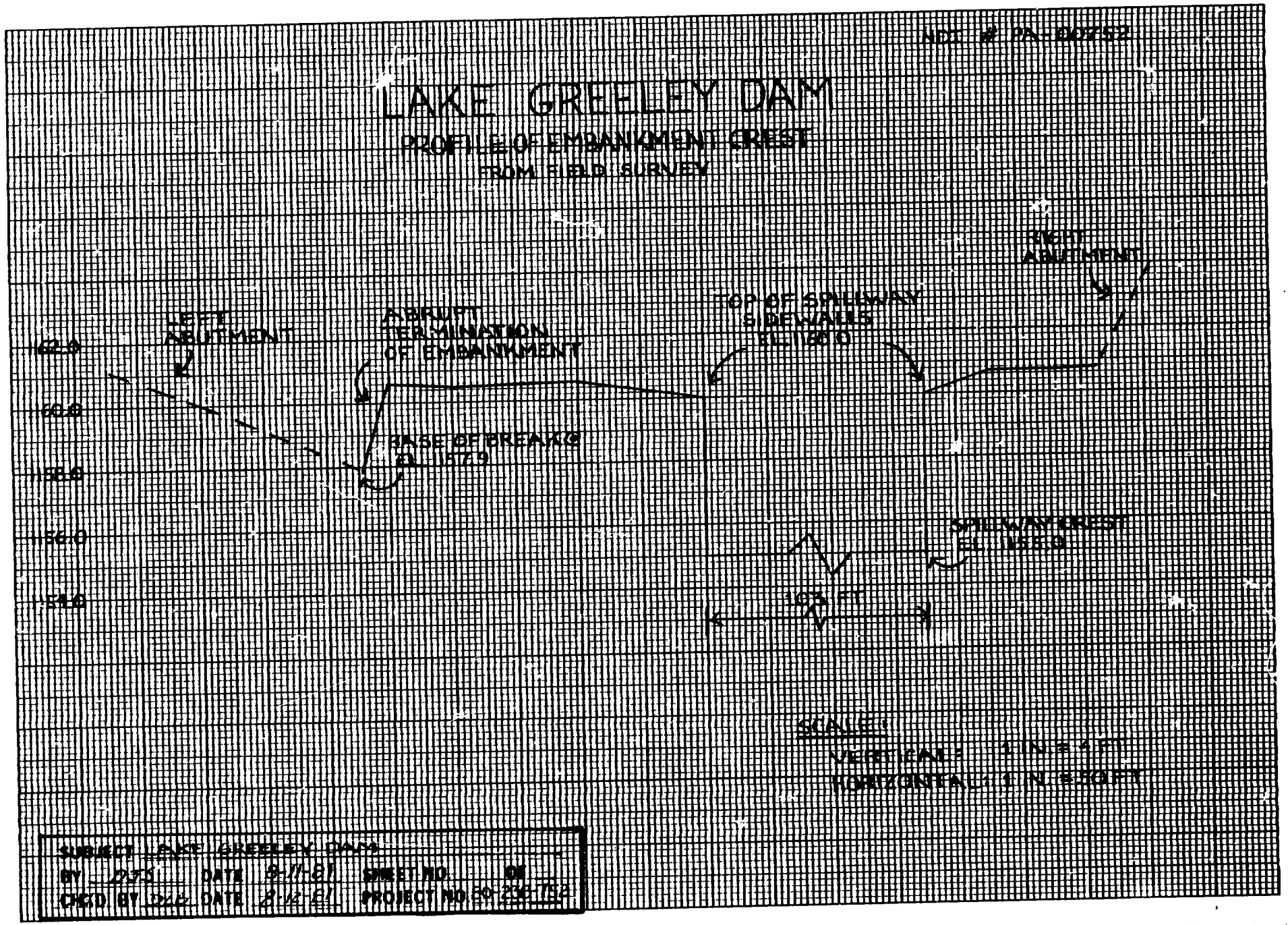
ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00752
MONUMENTATION SURVEYS	None.
OBSERVATION WELLS	None.
WEIRS	None.
PIEZOMETERS	None.
OTHERS	

RESERVOIR AREA AND DOWNSTREAM CHANNEL

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00752
SLOPES: RESERVOIR	Gentle to moderate, wooded slopes along the southern shore of the lake and moderate to steep, wooded slopes along the northern shore.
SEDIMENTATION	None observed.
DOWNSTREAM CHANNEL (OBSTRUCTIONS, DEBRIS, ETC.)	Township road and embankment with a 20 foot wide, concrete, arched culvert is located about 50 feet downstream of the spillway. Sylvania Lake Dam, an 8-foot high earth embankment with about 44 acre-feet maximum storage capacity, is located approximately 6,600 feet downstream.
SLOPES: CHANNEL VALLEY	Gentle to moderate sloped channel set in a narrow, wooded valley with steep confining slopes.
APPROXIMATE NUMBER OF HOMES AND POPULATION	Six or seven inhabited structures are situated near the stream along the approximate four mile reach between the dam and Shohola Creek. It is estimated that as many as 30 lives could be affected along this reach by the floodwave resulting from sudden failure of Lake Greeley Dam.



LAKE GREELEY DAM
GENERAL PLAN-FIELD INSPECTION NOTES



APPENDIX B

ENGINEERING DATA CHECKLIST

CHECK LIST
ENGINEERING DATA
PHASE I

NAME OF DAM Lake Greeley Dam

ITEM	REMARKS NDI# PA - 00752
PERSONS INTERVIEWED AND TITLE	Mark Buynak - partner; Lohikan Camps (via telephone).
REGIONAL VICINITY MAP	See Figure 1, Appendix E.
CONSTRUCTION HISTORY	Present facility constructed sometime between 1956 and 1958. See Section 1.2.g "Historical Data".
AVAILABLE DRAWINGS	Two drawings available from PennDER files, dated April 1956, by Michael A. Policelli, P.E. (see Figures 3 and 4, Appendix E).
TYPICAL DAM SECTIONS	See Figure 4, Appendix E.
OUTLETS: PLAN DETAILS DISCHARGE RATINGS	See Figure 4, Appendix E. Discharge rating curves are not available.

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS	NDIE PA - 00752
SPILLWAY: PLAN SECTION DETAILS	See Figures 3 and 4, Appendix E.	
OPERATING EQUIP- MENT PLANS AND DETAILS	See Figures 3 and 4, Appendix E.	
DESIGN REPORTS	None available.	
GEOLOGY REPORTS	None available.	
DESIGN COMPUTATIONS: HYDROLOGY AND HYDRAULICS STABILITY ANALYSES SEEPAGE ANALYSES	None available.	
MATERIAL INVESTIGATIONS: BORING RECORDS LABORATORY TESTING FIELD TESTING	None available.	

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS	NDI# PA- 00752
BORROW SOURCES	Not known.	
POST CONSTRUCTION DAM SURVEYS	None.	
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None.	
HIGH POOL RECORDS	No day-to-day records of pool levels are available for the present facility.	
MONITORING SYSTEMS	None.	
MODIFICATIONS	There have been no significant modifications to the present facility since its completion in 1958.	

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS NDI# PA - 00752
PRIOR ACCIDENTS OR FAILURES	None recorded for the present facility. PennDER files contain records of embankment overtopping and breaching indicents prior to 1956; that is, prior to construction of the present facility.
MAINTENANCE: RECORDS MANUAL	No formal records or maintenance manual are available.
OPERATION: RECORDS MANUAL	No formal records or operations manual are available.
OPERATIONAL PROCEDURES	Self-regulating.
WARNING SYSTEM AND/OR COMMUNICATION FACILITIES	No formal warning system is presently in effect.
MISCELLANEOUS	

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

NDI ID # PA-00752
PENNDER ID # 52-20

SIZE OF DRAINAGE AREA: 7.3 square miles.

ELEVATION TOP NORMAL POOL: 1155.0 STORAGE CAPACITY: 290 acre-feet.

ELEVATION TOP FLOOD CONTROL POOL: - STORAGE CAPACITY: -

ELEVATION MAXIMUM DESIGN POOL: - STORAGE CAPACITY: -

ELEVATION TOP DAM: 1160.0* STORAGE CAPACITY: 878 acre-feet.*

SPILLWAY DATA

CREST ELEVATION: 1155.0 feet.

TYPE: Uncontrolled, rectangular channel with ogee shaped weir.

CREST LENGTH: 103 feet.

CHANNEL LENGTH: N/A.

SPILLOVER LOCATION: Near center of embankment.

NUMBER AND TYPE OF GATES: None.

OUTLET WORKS

TYPE: 6-inch diameter cast iron pipe.

LOCATION: Base of spillway weir about 31 feet from left sidewall.

ENTRANCE INVERTS: Not known.

EXIT INVERTS: 1149.8 (design); 1150.1 (field).

EMERGENCY DRAWDOWN FACILITIES: 6-inch diameter gate valve at discharge end.

HYDROMETEOROLOGICAL GAGES

TYPE: None.

LOCATION: -

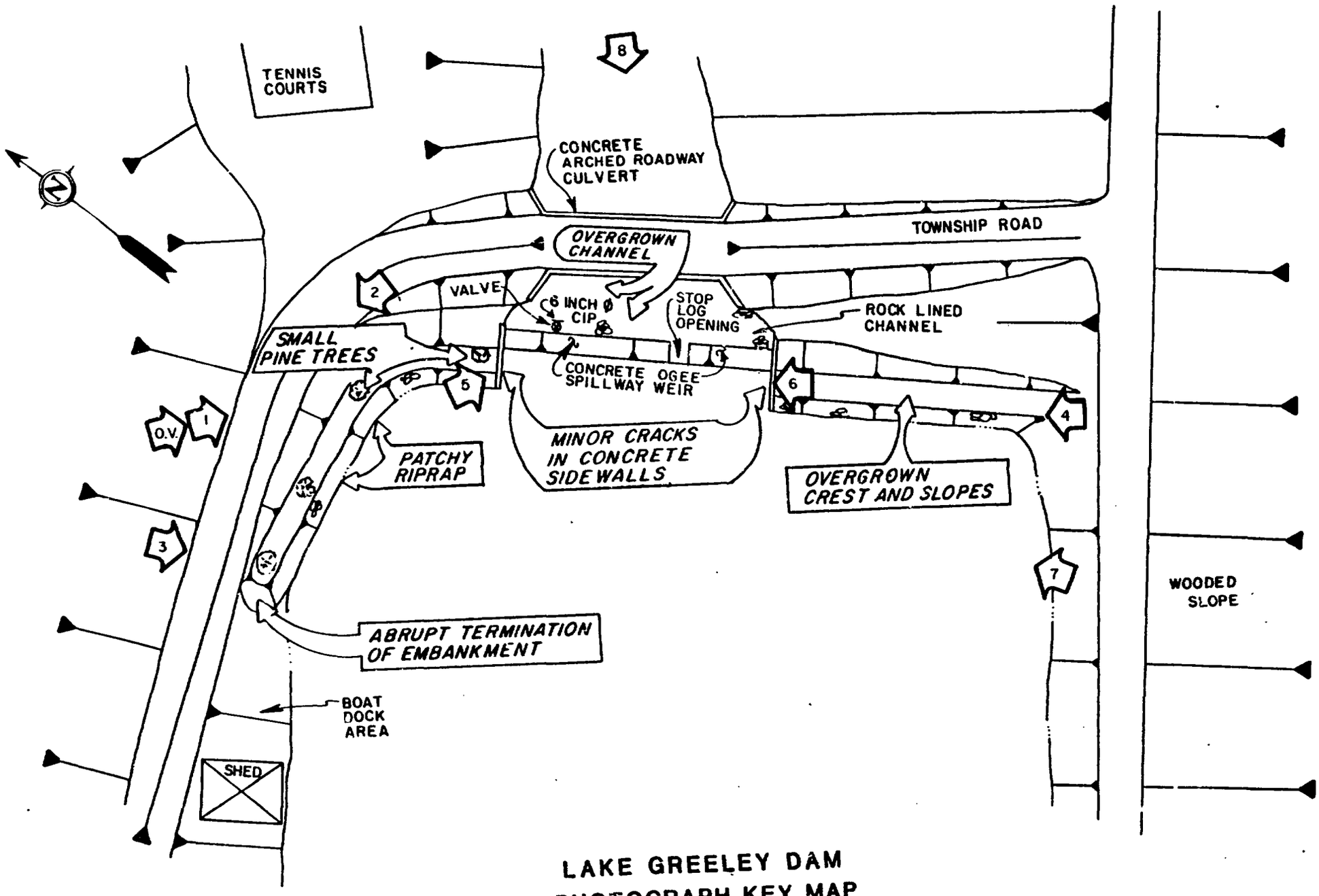
RECORDS: -

MAXIMUM NON-DAMAGING DISCHARGE: Not known.

*Neglecting low area at left end of embankment.

APPENDIX C

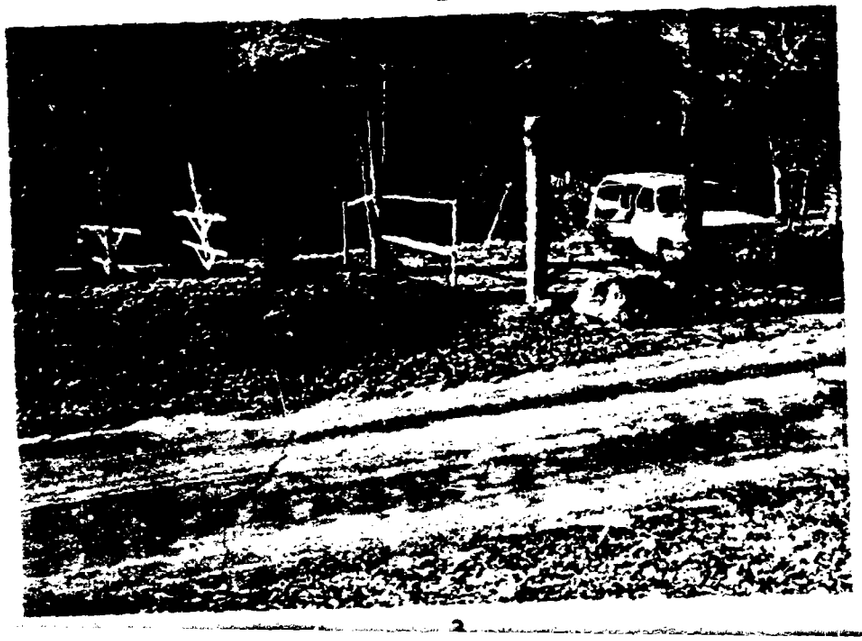
PHOTOGRAPHS



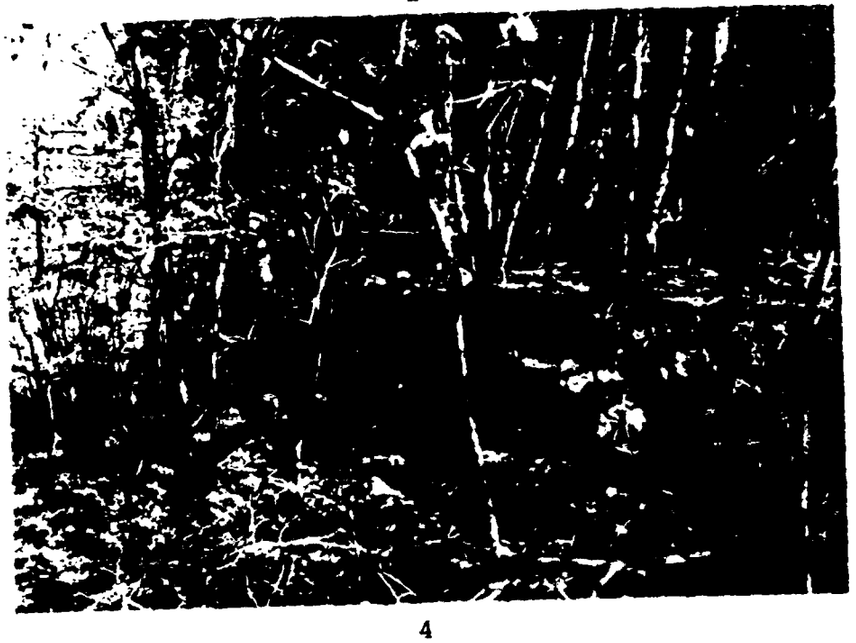
LAKE GREELEY DAM
PHOTOGRAPH KEY MAP

1

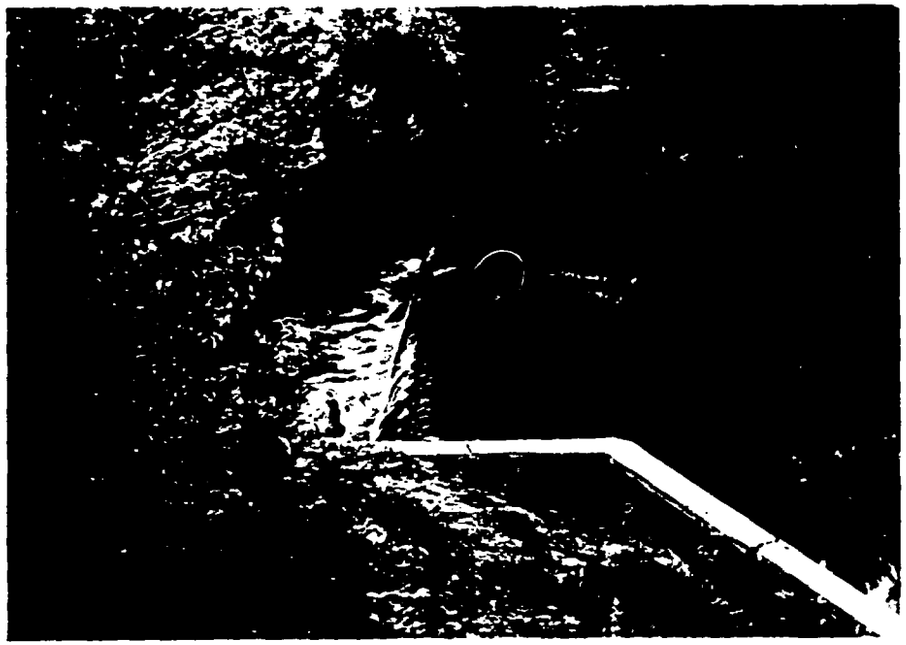
2



3



4



5

6

7

8

APPENDIX D

HYDROLOGIC AND HYDRAULIC ANALYSES

PREFACE

The modified HEC-1 program is capable of performing two basic types of hydrologic analyses: 1) the evaluation of the overtopping potential of the dam; and 2) the estimation of the downstream hydrologic-hydraulic consequences resulting from assumed structural failures of the dam. Briefly, the computational procedures typically used in the dam overtopping analysis are as follows:

a. Development of an inflow hydrograph(s) to the reservoir.

b. Routing of the inflow hydrograph(s) through the reservoir to determine if the event(s) analyzed would overtop the dam.

c. Routing of the outflow hydrograph(s) from the reservoir to desired downstream locations. The results provide the peak discharge(s), time(s) of occurrence the peak discharge(s), and the maximum stage(s) of each routed hydrograph at the downstream end of each reach.

The evaluation of the hydrologic-hydraulic consequences resulting from an assumed structural failure (breach) of the dam is typically performed as shown below.

a. Development of an inflow hydrograph(s) to the reservoir.

b. Routing of the inflow hydrograph(s) through the reservoir.

c. Development of a failure hydrograph(s) based on specified breach criteria and normal reservoir outflow.

d. Routing of the failure hydrograph(s) to desired downstream locations. The results provide estimates of the peak discharge(s), time(s) to peak and maximum water surface elevation(s) of failure hydrograph(s) for each location.

HYDROLOGY AND HYDRAULIC ANALYSIS
DATA BASE

NAME OF DAM: LAKE GREELEY DAM

PROBABLE MAXIMUM PRECIPITATION (PMP) = 21.5 INCHES/24 HOURS (1)

STATION	1	2	3
STATION DESCRIPTION	LAKE GREELEY DAM		
DRAINAGE AREA (SQUARE MILES)	7.3		
CUMULATIVE DRAINAGE AREA (SQUARE MILES)	-		
ADJUSTMENT OF PMF FOR DRAINAGE AREA LOCATION (%) (1)	ZONE 1		
6 HOURS	111		
12 HOURS	123		
24 HOURS	133		
48 HOURS	142		
72 HOURS	-		
SNYDER HYDROGRAPH PARAMETERS			
ZONE (2)	1		
C_p (3)	0.45		
C_t (3)	1.23		
L (MILES) (4)	5.4		
L_{ca} (MILES) (4)	2.5		
$t_p = C_t (L \cdot L_{ca})^{0.3}$ (HOURS)	2.69		
SPILLWAY DATA			
CREST LENGTH (FEET)	103		
FREEBOARD (FEET) (5)	2.9/5.0		

(1) HYDROMETEOROLOGICAL REPORT 33, U. S. ARMY CORPS OF ENGINEERS, 1956.
(2) HYDROLOGIC ZONE DEFINED BY CORPS OF ENGINEERS, BALTIMORE DISTRICT, FOR DETERMINATION OF SNYDER COEFFICIENTS (C_p AND C_t).
(3) SNYDER COEFFICIENTS
(4) L = LENGTH OF LONGEST WATERCOURSE FROM DAM TO BASIN DIVIDE
L_{ca} = LENGTH OF LONGEST WATERCOURSE FROM DAM TO POINT OPPOSITE BASIN CENTROID.
(5) TOP OF DAM/TOP OF SPILLWAY SIDEWALLS (SEE SHEET 8/26).

SUBJECT DAM SAFETY INSPECTION
LAKE GREELEY DAM

BY DTS DATE 7-7-81 PROJ. NO. 80-238-752

CHKD. BY DLB DATE 8-7-81 SHEET NO. 1 OF 26

GAI CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

DAM STATISTICS

HEIGHT OF DAM ≈ 10 FT (FIELD MEASURED: TOP OF SPILLWAY SIDEWALLS TO DOWNSTREAM INVERT OF OUTLET PIPE.)

NORMAL POOL STORAGE CAPACITY ≈ 94.5 x 10^6 GALLONS ≈ 290 AC-FT (FIG. 3)

(HEC-1)

MAXIMUM POOL STORAGE CAPACITY ≈ 878 AC-FT (@ TOP OF SPILLWAY SIDEWALLS)

STORAGE CAPACITY @ BASE OF "BREAK" IN EMBANKMENT ≈ 574 AC-FT (HEC-1) (SEE NOTE 1)

DRAINAGE AREA ≈ 7.3 SQ. MI. (PLANIMETERED ON USGS TOPO QUAD - ROWLAND, PA; SEE FIGURE 2.)

ELEVATIONS:

TOP OF DAM (DESIGN)	≈ 1160.0	(FIG 3, SEE NOTE 2)
TOP OF DAM - SPILLWAY SIDEWALLS (FIELD)	≈ 1160.0	
TOP OF DAM @ "BREAK" IN EMBANKMENT (SEE NOTE 1)	≈ 1160.6	(FIELD)
BASE OF "BREAK" IN EMBANKMENT (SEE NOTE 1)	≈ 1157.9	(FIELD)
NORMAL POOL	≈ 1155.0	(FIG. 1)
SPILLWAY CREST	≈ 1155.0	
UPSTREAM INLET INVERT (DESIGN)	≈ NOT KNOWN	
DOWNSTREAM OUTLET INVERT (DESIGN)	≈ 1149.8	(FIG 4, SEE NOTE 2)
DOWNTREAM OUTLET INVERT (FIELD)	≈ 1150.1	
DOWNSTREAM BASE OF OGEE	≈ 1150.8	(FIELD)
STREAMBED @ DAM CENTERLINE	≈ 1149	(EST., FIG 3)

SUBJECT DAM SAFETY INSPECTION
LAKE GREELEY DAM

BY DJS DATE 2-2-81 PROJ. NO. 80-238-752

CHKD. BY DLG DATE 8-7-81 SHEET NO. 2 OF 26

GAI CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

NOTE 1: IT CAN BE SEEN IN APPENDIX C, PHOTOGRAPH 3, THAT THERE IS AN ABRUPT TERMINATION OF THE EMBANKMENT NEAR ITS LEFT END, APPARENTLY PRESENT SINCE THE RECONSTRUCTION OF THE DAM IN THE LATE 1950's. THIS TERMINATION OF THE EMBANKMENT WILL BE REFERRED TO AS THE "BREAK" IN EMBANKMENT THROUGHOUT THESE CALCULATIONS.

NOTE 2: NORMAL POOL ELEVATION IS INDICATED TO BE AT 1155 FEET ACCORDING TO THE USGS TOPO QUAD – ROWLAND, PA. ELEVATIONS GIVEN IN THE DESIGN DRAWINGS ARE ADJUSTED ACCORDINGLY HERE — SPILLWAY CREST DATUM OF 92.2 FEET CORRESPONDS TO ELEVATION 1155.0.

DAM CLASSIFICATION

SIZE OF DAM:	SMALL	(REF 1, TABLE 1)
HAZARD CLASSIFICATION:	HIGH	(FIELD OBSERVATION)
REQUIRED SDF:	½ PMF TO PMF	(REF 1, TABLE 3)

HYDROGRAPH PARAMETERS

- LENGTH OF LONGEST WATERCOURSE: $L = 5.4$ MILES

- LENGTH OF LONGEST WATERCOURSE FROM DAM TO A POINT OPPOSITE BASIN CENTROID: $L_{ca} = 2.5$ MILES

(MEASURED ON USGS TOPO QUAD – ROWLAND, PA)

SUBJECT DAM SAFETY INSPECTION
LAKE GREELEY DAM

BY DTS DATE 7-7-81 PROJ. NO. 80-238-752
CHKD. BY DLG DATE 8-7-81 SHEET NO. 3 OF 76

GAI CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

$C_t = 1.23$
$C_p = 0.45$

(SUPPLIED BY C.O.E.; ZONE 1, DELAWARE RIVER BASIN)

SNYDER'S STANDARD LAG: $t_p = C_t (L \cdot L_{CA})^{0.3}$
$= 1.23 (5.4 \times 2.5)^{0.3}$
$= \underline{2.69}$ HOURS

(NOTE: HYDROGRAPH VARIABLES USED HERE ARE DEFINED IN REF. 2, IN SECTION ENTITLED "SNYDER SYNTHETIC UNIT HYDROGRAPH.")

RESERVOIR STORAGE CAPACITY

RESERVOIR SURFACE AREAS:

SURFACE AREA (S.A.) @ NORMAL POOL (EL. 1155.0) = 72 ACRES

S.A. @ EL. 1160 = 165 ACRES (TOP OF SPILLWAY WINGWALLS)
S.A. @ EL. 1180 = 250 ACRES

(PLANIMETERED ON USGS TOPO QUAD – ROWLAND, PA)

S.A. @ BASE OF "BREAK" IN EMBANKMENT (EL. 1157.9) = 125.9 ACRES

(BY LINEAR INTERPOLATION)

"ZERO-STORAGE" ELEVATION:

BY USE OF THE CONIC METHOD,

RESERVOIR VOLUME @ NORMAL POOL = $\frac{1}{3}HA$

SUBJECT DAM SAFETY INSPECTION
LAKE GREELEY DAM

BY DJS DATE 7-7-81 PROJ. NO. 80-238-752

CHKD. BY DLB DATE 8-7-81 SHEET NO. 4 OF 26

GAI CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

WHERE H = MAXIMUM DEPTH OF RESERVOIR, IN FT,
A = SURFACE AREA @ NORMAL POOL = 72 ACRES

$VOL = \frac{1}{3} HA$

$290 \text{ AC-FT} = \frac{1}{3} H (72 \text{ AC})$

$\therefore H = 12.1 \text{ FT}$

$\therefore$ ZERO-STORAGE ASSUMED @ 1155.0 - 12.1 = 1142.9

NOTE: ALTHOUGH THE MINIMUM RESERVOIR ELEVATION OCCURS AT SOME ELEVATION ABOVE 1142.9, THIS VALUE MUST BE USED IN THE HEC-1 INPUT IN ORDER TO MAINTAIN A STORAGE OF 290 AC-FT AT NORMAL POOL.

ELEVATION - STORAGE RELATIONSHIP:

THE ELEVATION-STORAGE RELATIONSHIP IS COMPUTED INTERNALLY IN THE HEC-1 PROGRAM, BY USE OF THE CONIC METHOD, BASED ON THE ELEVATION - SURFACE AREA DATA GIVEN ABOVE (SEE SUMMARY INPUT/OUTPUT SHEETS).

SUBJECT DAM SAFETY INSPECTION
LAKE GREELEY DAM

BY DJS DATE 7-7-81 PROJ. NO. 80-238-752
CHKD. BY DLB DATE 8-7-81 SHEET NO. 5 OF 26

CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

PMP CALCULATIONS

- APPROXIMATE RAINFALL INDEX = 21.5 INCHES

(CORRESPONDING TO A DURATION OF 24 HOURS AND A DRAINAGE AREA OF 200 SQUARE MILES)

(REF 3, FIG. 1)

- DEPTH-AREA-DURATION ZONE 1 (REF 3, FIG. 1)

- ASSUME DATA CORRESPONDING TO A 10-SQUARE MILE AREA MAY BE APPLIED TO THIS 7.3 SQUARE MILE BASIN:

DURATION (HRS)	PERCENT OF INDEX RAINFALL
6	111
12	123
24	133
48	142

(REF 3, FIG. 2)

HAP BROOK FACTOR (ADJUSTMENT FOR BASIN SHAPE AND FOR THE LESSER LIKELIHOOD OF A SEVERE STORM CENTERING OVER A SMALL BASIN) FOR A DRAINAGE AREA OF 7.3 SQUARE MILES IS 0.80.

(REF 4, p. 48)

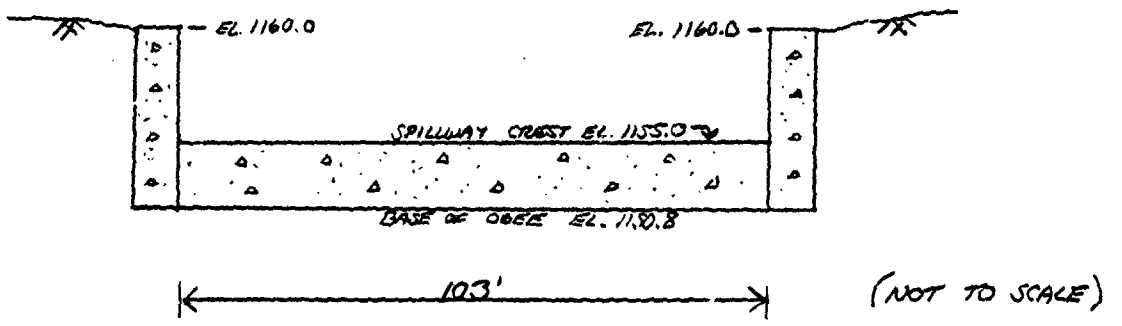
SUBJECT DAM SAFETY INSPECTION
LAKE GREELEY DAM

BY JJS DATE 7-8-81 PROJ. NO. 80-238-752
CHKD. BY DLB DATE 8-7-81 SHEET NO. 6 OF 26

GAI CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

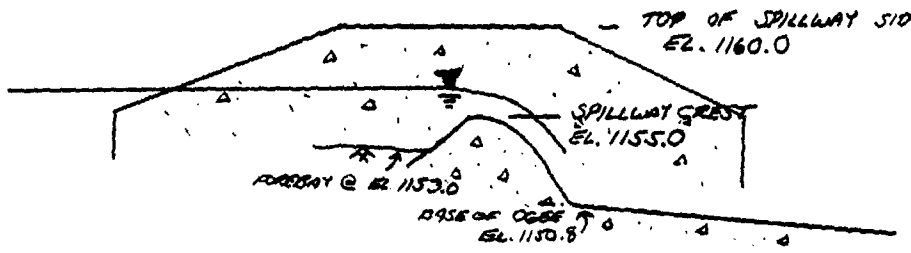
SPILLWAY CAPACITY

CROSS-SECTION:



(NOT TO SCALE)

PROFILE:



(NOT TO SCALE)

- - SKETCHES BASED ON FIELD MEASUREMENTS.

THE SPILLWAY CONSISTS OF AN UNCONTROLLED, RECTANGULAR SHAPED, CONCRETE CHANNEL WITH A CONCRETE OGEE-TYPE WEIR. THE SPILLWAY DISCHARGE FLOWS THROUGH A CONCRETE ARCH CULVERT UNDER THE ROADWAY EMBANKMENT LOCATED IMMEDIATELY DOWNSTREAM OF THE DAM. ALTHOUGH THERE WOULD BE TAILWATER EFFECTS FROM THE CULVERT THAT WOULD SIGNIFICANTLY REDUCE THE CAPACITY OF THE SPILLWAY, THEY ARE NOT CONSIDERED IN THIS PORTION OF THE ANALYSIS.

SUBJECT DAM SAFETY INSPECTION
LAKE GREELEY DAM

BY DJS DATE 7-13-81 PROJ. NO. 80-238-752

CHKD. BY DLB DATE 8-7-81 SHEET NO. 7 OF 26

CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

DISCHARGE OVER THE WEIR CAN BE ESTIMATED BY THE RELATIONSHIP

$$Q = CLH^{3/2} \qquad \text{(REF 4, p. 373)}$$

WHERE Q = DISCHARGE OVER WEIR, IN CFS,
C = COEFFICIENT OF DISCHARGE,
L = LENGTH OF WEIR CREST = 103 FT,
H = HEAD, IN FT.

IT IS ASSUMED THAT THE RELATIONSHIPS FOR OGEE-TYPE WEIRS, GIVEN IN REF 4, pp 372-382, CAN BE APPLIED HERE. THE DESIGN HEAD IS ASSUMED TO BE AT THE TOP OF THE SPILLWAY SIDEWALLS, OR 5.0 FT. FOR A FOREBAY DEPTH OF ABOUT 2.0 FT,

$$\frac{P}{H_o} = \frac{2.0}{5.0} = 0.4$$

$$\therefore C_o = 3.76$$

AS THE HEAD ON THE WEIR BECOMES SMALL, DISCHARGE IS REDUCED DISPROPORTIONATELY, DUE TO THE ROUGHNESS AND THE CONTACT PRESSURE BETWEEN THE WATER AND THE WEIR SURFACE. THUS, THE DISCHARGE COEFFICIENT (C) TAKES ON A VALUE LOWER THAN THAT OF DESIGN HEAD. THE OPPOSITE TREND OCCURS FOR HEADS GREATER THAN THAT OF DESIGN. THEREFORE, THE DISCHARGE COEFFICIENT WILL BE MODIFIED APPROPRIATELY, ACCORDING TO REF. 4, FIG. 250.

IT WILL ALSO BE ASSUMED THAT THERE ARE NO SIGNIFICANT APPROACH LOSSES HERE. THE SPILLWAY RATING TABLE IS PROVIDED ON SHEET 8.

SUBJECT DAM SAFETY INSPECTION
LAKE GREELEY DAM

BY DTS DATE 7-14-81 PROJ. NO. 80-238-752
CHKD. BY DLB DATE 8-7-81 SHEET NO. 8 OF 26

CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

SPILLWAY RATING TABLE:
(W/O TAILWATER CONSIDERATIONS)

RESERVOIR ELEVATIONS (FT)	H (FT)	H/H_o	C/C_o ①	C ②	Q ③ (CFS)
1155.0	0	—	—	—	0
1156.0	1.0	0.20	0.85	3.20	330
1157.0	2.0	0.40	0.90	3.38	980
1157.9 (BASE OF "CREST" IN ENTRANCE)	2.9	0.58	0.94	3.53	1800
1158.0	3.0	0.60	0.94	3.53	1890
1159.0	4.0	0.80	0.97	3.65	3010
1160.0 (TOP OF SPILLWAY SIDEWALLS)	5.0	1.00	1.00	3.76	4330
1161.0	6.0	1.20	1.02	3.84	5810
1162.0	7.0	1.40	1.05	3.95	7530
1163.0	8.0	1.60	1.07	4.02	9370
1164.0	9.0	1.80	1.07	4.02	11,180
1165.0	10.0	2.00	1.07	4.02	13,090

① FROM REF. 4, FIG. 250, p. 378
② $C = C/C_o \times C_o = C/C_o \times 3.76$
③ $Q = CLH^{3/2}$, WHERE $L = 103$ FT;
ROUNDED TO NEAREST 10 CFS.

SUBJECT DAM SAFETY INSPECTION
LAKE GREELEY DAM

BY DJS DATE 7-14-81 PROJ. NO. 80-238-752

CHKD. BY DLB DATE 8-7-81 SHEET NO. 9 OF 26

CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

EMBANKMENT/ABUTMENT OVERFLOW CALCULATIONS (W/O TAILWATER CONSIDERATIONS)

I) EXISTING CONDITIONS:

ASSUME THAT DISCHARGE OVER THE EMBANKMENT (AS WELL AS THROUGH THE "BREAK" IN THE EMBANKMENT) CAN BE MODELED AS FLOW OVER A BROAD-CRESTED WEIR. THUS, THE DISCHARGE CAN BE ESTIMATED BY THE RELATIONSHIP

$$Q = CLH^{3/2}$$ (REF 5, p. V-23)

WHERE Q = DISCHARGE OVER EMBANKMENT, IN CFS,
L = LENGTH OF EMBANKMENT OVERTOPPED, IN FT,
H = HEAD, IN FT; IN THIS CASE IT IS THE AVERAGE "FLOW AREA WEIGHTED HEAD" ABOVE THE MINIMUM EMBANKMENT CREST ELEVATION; AND
C = COEFFICIENT OF DISCHARGE; DEPENDENT UPON THE HEAD AND THE WEIR BREADTH.

LENGTH OF EMBANKMENT INUNDATED VS. RESERVOIR ELEVATION: (INCLUDES "BREAK" IN EMBANKMENT)

ELEVATION (FT)	LENGTH (FT)	ELEVATION (FT)	LENGTH (FT)
1157.9	15	1161.5	230
1159.0	20	1162.0	235
1160.0	25	1163.0	245
1160.3	65	1164.0	255
1160.5	90	1165.0	285
1160.6	175		
1160.7	180		
1161.0	230		

(BASED ON FIELD NOTES AND OBSERVATIONS AND USGS TOPO - ROWLAND,

SUBJECT DAM SAFETY INSPECTION
LAKE GREELEY DAM

BY DJS DATE 7-14-81 PROJ. NO. 80-238-752

CHKD. BY DLO DATE 8-7-81 SHEET NO. 10 OF 26

GAI CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

ASSUME THAT INCREMENTAL DISCHARGES OVER THE EMBANKMENT/ABUTMENT FOR SUCCESSIVE RESERVOIR ELEVATIONS ARE APPROXIMATELY TRAPEZOIDAL IN CROSS-SECTIONAL FLOW AREA. THEN ANY INCREMENTAL AREA OF FLOW CAN BE ESTIMATED AS $H_i [(L_1+L_2)/2]$, WHERE L_1 = LENGTH OF EMBANKMENT OVERTOPPED AT HIGHER ELEVATION, L_2 = LENGTH AT LOWER ELEVATION, H_i = DIFFERENCE IN ELEVATIONS. THUS, THE TOTAL AVERAGE "FLOW AREA WEIGHTED HEAD" CAN BE ESTIMATED AS $H_w = (\text{TOTAL FLOW AREA}/L_1)$.

EMBANKMENT/ABUTMENT RATING TABLE:

RESERVOIR ELEVATION (FT)	L_1 (FT)	L_2 (FT)	INCREMENTAL HEAD, H_i (FT)	INCREMENTAL FLOW AREA, A_i (FT²) ①	TOTAL FLOW AREA, A_T (FT²)	WEIGHTED HEAD, H_w (FT) ②	H_w/l ③	C ④	Q (CFS) ⑤
1157.9	15	—	—	—	—	—	—	—	0
1159.0	20	15	1.1	19	19	0.95	0.12	3.03	60
1160.0	25	20	1.0	23	42	1.7	0.21	3.08	170
1160.3	65	25	0.3	14	56	0.86	0.11	3.03	170 *
1160.5	90	65	0.2	16	72	0.80	0.10	3.03	200
1160.6	125	90	0.1	13	85	0.49	0.06	3.02	200 *
1160.7	180	125	0.1	18	103	0.57	0.07	3.02	230
1161.0	230	180	0.3	62	165	0.72	0.09	3.03	430
1161.5	230	230	0.5	115	280	1.2	0.15	3.05	920
1162.0	235	230	0.5	116	396	1.7	0.21	3.08	1600
1163.0	245	235	1.0	240	636	2.6	0.33	3.09	3170
1164.0	255	245	1.0	250	886	3.5	0.44	3.09	5160
1165.0	285	255	1.0	270	1156	4.1	0.51	3.09	7310

① $A_i = H_i [(L_1+L_2)/2]$
② $H_w = A_T/L_1$
③ l = BREADTH OF CREST = 8 FT (FIELD MEASURED)
④ $C = f(H_w, l)$; FROM REF 12, FIG. 24.
⑤ $Q = CL_1H_w^{3/2}$ (ROUNDED TO NEAREST 10 CFS)

* — CALCULATED VALUE OF Q LOWER THAN THAT OF PREVIOUS ELEVATION IN RATING TABLE, THEREFORE PREVIOUS VALUE USED.

SUBJECT DAM SAFETY INSPECTION
LAKE GREELEY DAM

BY DJS DATE 7-14-81 PROJ. NO. 80-238-752
CHKD. BY DLB DATE 8-7-81 SHEET NO. 11 OF 26

GAI CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

TOTAL FACILITY RATING TABLE

$Q_{TOTAL} = Q_{SPILLWAY} + Q_{EMBANKMENT}$

RESERVOIR ELEVATION (FT)	① $Q_{SPILLWAY}$ (CFS)	② $Q_{EMBANKMENT}$ (CFS)	Q_{TOTAL} (CFS)
1155.0	0	—	0
1156.0	330	—	330
1157.0	980	—	980
1157.9 (BASE OF "BREAK" IN EMBANKMENT)	1800	0	1800
1158.0	1890	0	1890
1159.0	3010	60	3070
1160.0 (TOP OF SPILLWAY SIDEWALLS)	4330	170	4500
1160.3	4770 *	170	4940
1160.5	5070 *	200	5270
1160.7	5370 *	230	5600
1161.0	5810	430	6240
1161.5	6670 *	920	7590
1162.0	7530	1600	9130
1163.0	9370	3170	12,540
1164.0	11,180	5160	16,340
1165.0	13,090	7310	20,400

* - BY LINEAR INTERPOLATION (ROUNDED TO NEAREST 10 CFS)

① FROM SHEET 8.

② FROM SHEET 10.

II) EMBANKMENT REGRADED:

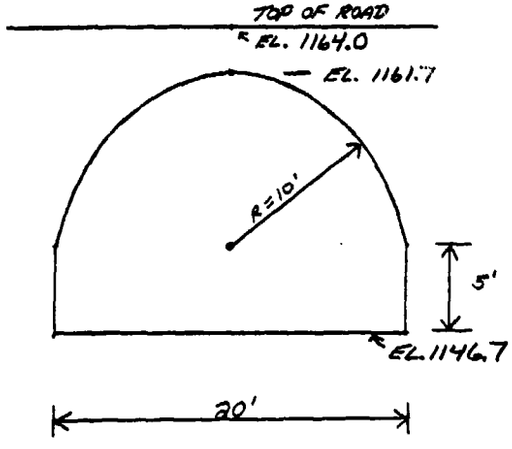
THE DISCHARGE THROUGH THE "BREAK" IN THE EMBANKMENT AT EL. 1160.0 (TOP OF DAM) IS RELATIVELY SMALL (170 CFS) COMPARED TO THE TOTAL DISCHARGE CAPACITY (4500 CFS) AT THIS ELEVATION. THEREFORE, FOR THE PURPOSE OF THIS ANALYSIS, IT IS ASSUMED THAT THE TOTAL FACILITY RATING TABLE WITH THE ENTIRE EMBANKMENT INTACT IS APPROXIMATELY THE SAME AS THAT FOR THE EXISTING CONDITIONS.

SUBJECT DAM SAFETY INSPECTION
LAKE GREELEY DAM

BY DJS DATE 7-9-81 PROJ. NO. 80-238-752
CHKD. BY DLB DATE 8-6-81 SHEET NO. 12 OF 26

GAI CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

CAPACITY OF ROADWAY CULVERT:



(NOT TO SCALE)

THE ROADWAY CULVERT CONSISTS OF A CONCRETE SEMI-CIRCULAR ARCH TYPE CULVERT, AS SKETCHED ABOVE. DISCHARGE THROUGH THE CULVERT CAN BE ESTIMATED BY THE EQUATIONS OF FLOW FOR BOX CULVERTS UNDER INLET CONTROL, USING ADJUSTED FLOW AREAS (SEE NOTE 3):

FOR $H/D < 1.2$, $Q = \frac{2}{3} C_B A_F \sqrt{\frac{2}{3} g H}$

FOR $H/D > 1.2$, $Q = C_H A_F \sqrt{2g(H - C_H D)}$

WHERE Q = FLOW THROUGH CULVERT, IN CFS,
A_F = AREA OF FLOW THROUGH CULVERT, IN FT^2,
H = HEAD ON CULVERT, IN FT, = W.S.EL. − 1146.7;

NOTE 3: FROM OPEN CHANNEL FLOW, F.M. HENDERSON, MACMILLAN PUBLISHING CO., INC., NEW YORK, 1966, PP. 263-264.

SUBJECT DAM SAFETY INSPECTION
LAKE GREELEY DAM

BY DJS DATE 7-9-81 PROJ. NO. 80-238-752
CHKD. BY DLB DATE 8-6-81 SHEET NO. 13 OF 26

GAI CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

C_B = CONTRACTION COEFFICIENT = 0.9 (SQUARE-EDGED ENTRANCE),
C_H = CONTRACTION COEFFICIENT = 0.6 (SQUARE-EDGED ENTRANCE),
g = GRAVITATIONAL CONSTANT = 32.2 FT/SEC^2.
D = HEIGHT OF CULVERT = 15.0 FT.

— DETERMINE A_F FOR VARIOUS DEPTHS OF FLOW:

— FOR $d \leq 5.0$ FT (WHERE d = DEPTH OF FLOW AT CULVERT ENTRANCE = H),

$$A_F = 20d$$

— FOR $d > 5.0$ FT, A_F WILL BE DETERMINED USING REF. 7, APPENDIX A: "GEOMETRIC ELEMENTS FOR CIRCULAR CHANNEL SECTIONS," p.625.

WHERE y = FLOW DEPTH IN A CIRCULAR PIPE, IN FT,
d_o = DIAMETER OF PIPE, IN FT,
A_c = AREA OF FLOW IN A CIRCULAR PIPE, IN FT^2.

TO DETERMINE A_F,

SAY $y = d + 5$,
$d_o = 20$ FT,

$$A_F = (5)(20) + A_c - \left(\frac{1}{2}\right)\frac{\pi d_o^2}{4}$$
$$A_F = A_c - 57.1$$

— FOR $d \geq 15.0$, $A_F = 5(20) + \left(\frac{1}{2}\right)\frac{\pi(20^2)}{4}$
$= 257.1$ FT^2 (CONSTANT)

SUBJECT DAM SAFETY INSPECTION
LAKE GREELEY DAM

BY JJS DATE 7-9-81 PROJ. NO. 80-238-752

CHKD. BY DLB DATE 8-6-81 SHEET NO 14 OF 26

CONSULTANTS, INC
Engineers • Geologists • Planners
Environmental Specialists

CULVERT RATING TABLE:

H = d (FT)	① y (FT)	② $\frac{y}{d_o}$	③ $\frac{A_c}{d_o^2}$	④ A_c (FT^2)	⑤ A_F (FT^2)	⑥ H/D	⑦ Q (CFS)	⑧ ELEVATION (FT)
0	—	—	—	—	0	—	0	1146.7
1	—	—	—	—	20	0.1	56	1147.7
3	—	—	—	—	60	0.2	289	1149.7
5	—	—	—	—	100	0.3	622	1151.7
7	12	0.60	0.4920	196.8	139.7	0.5	1027	1153.7
9	14	0.70	0.5872	234.9	177.8	0.6	1483	1155.7
11	16	0.80	0.6736	269.4	212.3	0.7	1957	1157.7
13	18	0.90	0.7445	297.8	240.7	0.9	2413	1159.7
15	20	1.00	0.7854	314.2	257.1	1.0	2768	1161.7
17	—	—	—	—	257.1	1.1	2947	1163.7
19	—	—	—	—	257.1	1.3	3915	1165.7
20	—	—	—	—	257.1	1.3	4106	1166.7
21	—	—	—	—	257.1	1.4	4288	1167.7

① $y = d + 5$

② $d_o = 20$ FT

③ FROM REF. 7, APPENDIX A

④ $A_c = \frac{A_c}{d_o^2} \times (20)^2$

⑤ SEE SHEET 13.

⑥ $D = 15$ FT

⑦ SEE SHEET 12.

⑧ ELEVATION = 1146.7 + H

SUBJECT DAM SAFETY INSPECTION
LAKE GREELEY DAM

BY DJS DATE 7-23-81 PROJ. NO. 80-238 752

CHKD. BY DLB DATE 8-6-81 SHEET NO. 15 OF 26

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

DISCHARGE OVER ROADWAY

ASSUME THAT THE ROADWAY ACTS ESSENTIALLY AS A BROAD CRESTED WEIR WHEN OVERTOPPING OCCURS. THEN THE DISCHARGE OVER THE ROADWAY CAN BE ESTIMATED AS

$Q = CLH^{3/2}$ (SEE SHEET 9).

RATING TABLE*:

ELEVATION (FT)	① L_1 (FT)	L_2 (FT)	INCREMENTAL HEAD, H_i (FT)	② INCREMENTAL FLOW AREA, A_i (FT^2)	TOTAL FLOW AREA, A_T (FT^2)	③ WEIGHTED HEAD, H_w (FT)	④ $Q_{ROADWAY}$ (CFS)
1157.8	50	—	—	—	—	—	0
1158.0	90	50	0.2	14	14	0.16	17
1159.0	105	90	1.0	98	112	1.1	363
1160.0	125	105	1.0	115	227	1.8	906
1161.0	145	125	1.0	135	362	2.5	1719
1162.0	160	145	1.0	153	515	3.2	2748
1163.0	180	160	1.0	170	685	3.8	4000
1164.0	200	180	1.0	190	875	4.4	5538
1165.0	250	200	1.0	225	1100	4.4	6922
1166.0	370	250	1.0	310	1410	3.8	8222
1167.0	380	370	1.0	375	1785	4.7	11,616
1168.0	385	380	1.0	383	2168	5.6	15,306

① L_1 = LENGTH OF ROADWAY OVERTOPPED; VALUES DETERMINED FROM FIELD SURVEY AND USGS TOPO QUAD - ROWLAND, PA.

② $A_i = H_i [(L_1 + L_2)/2]$

③ $H_w = A_T / L_1$

④ $Q_{ROADWAY} = CL_1 H_w^{3/2}$; ASSUME C ON THE ORDER OF 3.0.

* - SEE SHEETS 9, 10 FOR ASSUMPTIONS + METHODOLOGY.

SUBJECT DAM SAFETY INSPECTION
LAKE GREELEY DAM

BY DJS DATE 2-23-81 PROJ. NO. 80-238-752

CHKD. BY DLG DATE 3-6-81 SHEET NO. 16 OF 26

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

TOTAL RATING CURVE FOR DOWNSTREAM ROADWAY

$Q_{TOTAL} = Q_{CULVERT} + Q_{ROADWAY}$

RESERVOIR ELEVATION (FT)	① $Q_{CULVERT}$ (CFS)	② $Q_{ROADWAY}$ (CFS)	③ Q_{TOTAL} (CFS)
1146.7	0	-	0
1147.7	56	-	60
1149.7	289	-	290
1151.7	622	-	620
1153.7	1027	-	1030
1155.7	1483	-	1480
1157.8	1980*	0	1980
1158.0	2025	17	2040
1159.0	2253	363	2620
1160.0	2466	906	3370
1161.0	2644	1719	4360
1162.0	2795	2748	5540
1163.0	2884	4000	6880
1164.0	3092	5538	8630
1165.0	3576	6922	10,500
1166.0	3972	8222	12,190
1167.0	4161	11,616	15,780

① FROM SHEET 14.
② FROM SHEET 15.
③ ROUNDED TO NEAREST 10 CFS.

* - VALUES OF $Q_{CULVERT}$ AT EL 1157.8 AND ABOVE LINEARLY INTERPOLATED FROM RATING TABLE, SHEET 14.

SUBJECT DAM SAFETY INSPECTION
LAKE GREELEY DAM

BY RJS DATE 7-15-81 PROJ. NO. 80-238-252

CHKD. BY DLB DATE 8-7-81 SHEET NO. 17 OF 26

GAI CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

DOWNSTREAM ROUTING

SYLVANIA LAKE DAM: SYLVANIA LAKE DAM IS LOCATED LESS THAN TWO MILES DOWNSTREAM OF LAKE GREELEY DAM. DISCHARGE FROM LAKE GREELEY DAM IS ROUTED DIRECTLY THROUGH SYLVANIA LAKE.

- DAM STATISTICS:

  - HEIGHT OF DAM ≈ 8 FT (FIELD MEASURED)
  - ELEVATION OF NORMAL POOL = 1070 (EST. ON USGS TOPO - SHOHOLA, PA
  - ELEVATION OF TOP OF DAM = 1072 (FIELD MEASURED)

- RESERVOIR STORAGE CAPACITY:

  S.A. @ NORMAL POOL (EL. 1070) = 10 ACRES
  S.A. @ EL. 1080 = 31 ACRES
  S.A. @ EL. 1100 = 94 ACRES
  (PLANIMETERED ON USGS TOPO QUADS - ROWLAND, AND SHOHOLA, PA)

  S.A. @ TOP OF DAM (EL. 1072) = 14.2 ACRES
  (BY LINEAR INTERPOLATION)

- ASSUME MINIMUM RESERVOIR ELEVATION AT 1064, THE APPROXIMATE ELEVATION OF THE BASE OF THE SPILLWAY WEIR.

THE ELEVATION-STORAGE RELATIONSHIP IS COMPUTED INTERNALLY IN THE HEC-1 PROGRAM, BASED ON THE SURFACE AREA - ELEVATION DATA GIVEN ABOVE.

SUBJECT DAM SAFETY INSPECTION
LAKE GREELEY DAM

BY DJS DATE 7-15-81 PROJ. NO. 80-238

CHKD. BY DLG DATE 8-7-81 SHEET NO. 18 OF 26

GAI CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

- SPILLWAY CAPACITY:

THE SPILLWAY CONSISTS OF A CONCRETE OGEE-LIKE WEIR, WITH A CREST LENGTH OF APPROXIMATELY 40 FT, AND A FREEBOARD OF 2.0 FT TO THE TOP OF THE DAM.

DISCHARGE OVER THE WEIR IS ESTIMATED BY THE EQUATION

$$Q = CLH^{3/2}$$ (SEE SHEET 7)

WHERE THE DISCHARGE COEFFICIENT IS ASSUMED TO BE ON THE ORDER OF 3.6 (REF. 4).

THE SPILLWAY RATING TABLE IS COMPUTED INTERNALLY IN THE HEC-1 PROGRAM, BASED ON THE WEIR EQUATION AND THE ABOVE DATA.

- EMBANKMENT RATING TABLE:

DISCHARGE OVER THE EMBANKMENT WILL BE COMPUTED INTERNALLY IN THE HEC-1 PROGRAM, BASED ON THE ASSUMPTION THAT CRITICAL DEPTH OCCURS ON THE CREST, AND WITH THE CREST PROFILE REPRESENTED BY A SERIES OF TRAPEZOIDS.

INPUT DATA:

CREST LENGTH:	100 FT	300	600
AT OR BELOW ELEVATION:	1072.0	1080.0	1130.0

(BASED ON FIELD NOTES AND USGS TOPO QUAD – SHOHOLA, PA)

SUBJECT LAKE GREELEY DAM	
BY [illegible] DATE [illegible]	SHEET NO. 13 OF 40
CHKD BY [illegible] DATE [illegible]	PROJECT NO. [illegible]

DOWNSTREAM ROUTING SECTIONS

SECTION 1

≈ 7350 FT D.S. FROM LAKE GREELEY DAM

INVERT ≈ 1053

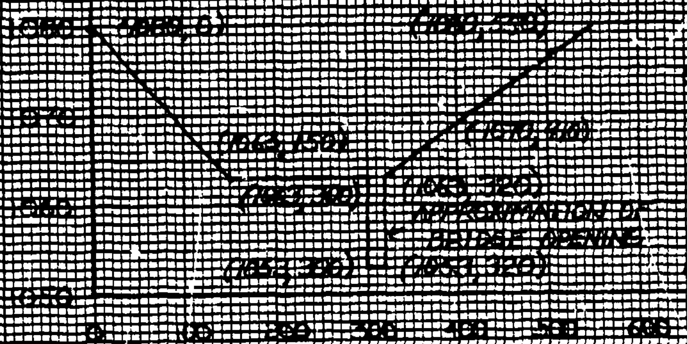
CHANNEL SLOPE ≈ 0.024

$n_{LOB} = n_{ROB} = 0.070$

$n_{CH} = 0.045$

REACH LENGTH ≈ 7350 FT (FROM SYLVANIA LAKE)

DAMAGE LEVEL ≈ 1063



SECTION 2

≈ 14850 FT D.S. FROM LAKE GREELEY DAM

INVERT ≈ 1000

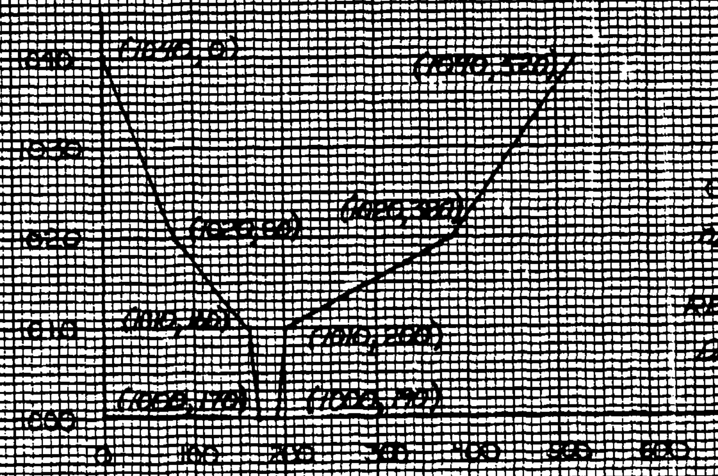
CHANNEL SLOPE ≈ 0.026

$n_{LOB} = n_{ROB} = 0.080$

$n_{CH} = 0.045$

REACH LENGTH ≈ 7500 FT

DAMAGE LEVEL ≈ 1010



(NOTE: SECTIONS BASED ON FIELD NOTES AND OBSERVATIONS AND USGS TOPO QUADS ROWLAND AND SHOHOLA, PA. ELEVATIONS ARE CONSIDERED ESTIMATES AND ARE NOT NECESSARILY ACCURATE.)

SECTION 3

≈ 11,130 FT. D.S. FROM LAKE GREELEY DAM

INVERT ≈ 929

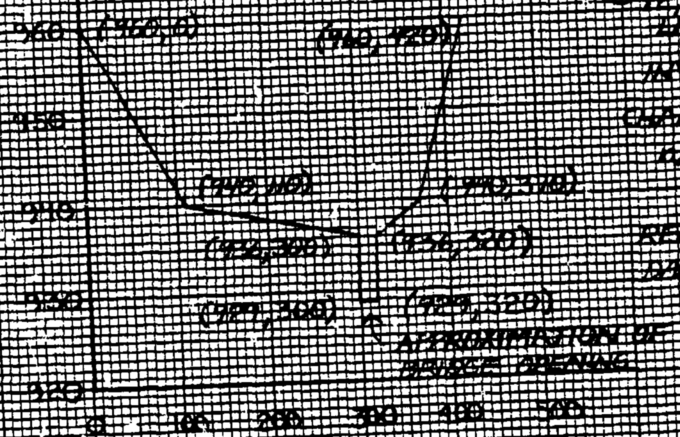
CHANNEL SLOPE ≈ 0.018

n_{LOB} = 0.080 , n_{ROB} = 0.100

n_{CH} = 0.045

REACH LENGTH ≈ 2780 FT

DAMAGE LEVEL ≈ 936



SECTION 4

≈ 13,400 FT. D.S. FROM LAKE GREELEY DAM

INVERT ≈ 913

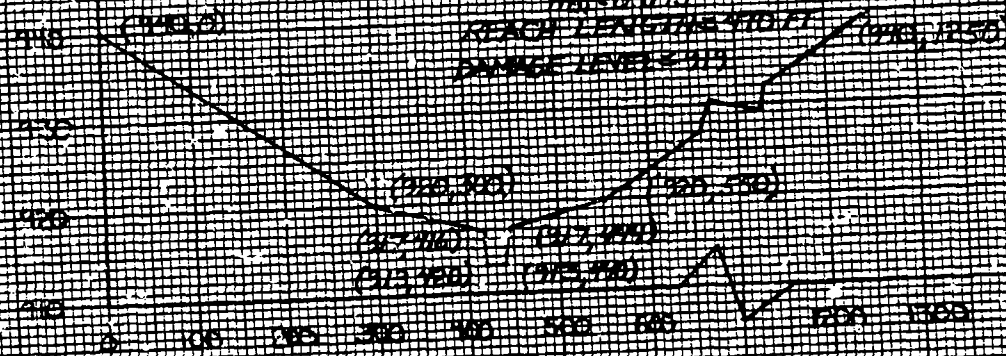
CHANNEL SLOPE ≈ 0.015

n_{LOB} = n_{ROB} = 0.080

n_{CH} = 0.045

REACH LENGTH ≈ 410 FT

DAMAGE LEVEL ≈ 917



SUBJECT DAM SAFETY INSPECTION
LAKE GREELEY DAM

BY DJS DATE 8-4-81 PROJ. NO. 80-238-752

CHKD. BY DLB DATE 8-7-81 SHEET NO. 21 OF 26

BREACH ANALYSIS AND CONCLUSIONS

EFFECTS OF TAILWATER ON SPILLWAY CAPACITY:

IT IS ASSUMED THAT THE RELATIONSHIPS GIVEN IN REF. 4, pp. 376-382, FOR TAILWATER EFFECTS ON OGEE WEIR FLOW, MAY BE APPLIED HERE.

- AT ELEV. 1157.9 (BASE OF "BREAK" IN EMBANKMENT):

H = 2.9 FT (OVER SPILLWAY CREST)

Q_1 = FREE DISCHARGE (NO TW EFFECTS) = 1800 CFS

(SHEET

AT Q = 1800 CFS, TW ELEV = 1157.0, BY LINEAR INTERPOLATION FROM RATING TABLE, SHEET 16.

h_d = RESERVOIR ELEVATION − TAILWATER ELEVATION
= 1157.9 − 1157.0 = 0.9 FT

$\frac{h_d}{H} = \frac{0.9}{2.9} = 0.31$

FROM REF. 4, FIG. 354, FOR $\frac{h_d}{H}$ = 0.31,

$\frac{C_s}{C} = 0.94$

WHERE $\frac{C_s}{C}$ = RATIO OF MODIFIED DISCHARGE COEFFICIENT TO FREE DISCHARGE COEFFICIENT.

$\therefore \quad Q = (0.94)(1800) = 1690$ CFS.

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

AT Q = 1690 CFS, TW ELEV = 1156.6

$h_d = 1157.9 - 1156.6 = 1.3$

$\frac{h_d}{H} = \frac{1.3}{2.9} = 0.45$

$\therefore \frac{C_s}{C} = 0.97$

2nd ITERATION, TRY Q = 1730 CFS

TW ELEV = 1156.8

$h_d = 1157.9 - 1156.8 = 1.1$

$\frac{h_d}{H} = \frac{1.1}{2.9} = 0.38$

$\therefore C_s/C = 0.96$

$\therefore Q = (0.96)(1800) = 1730$ CFS ✓

$\therefore$ AT EL. 1157.9, Q = 1730 CFS. ←

AT EL. 1160.0 (TOP OF SPILLWAY SIDEWALLS):

H = 5.0 FT (OVER SPILLWAY CREST)

Q_1 = 4330 CFS (SHEET 8)

AT Q = 4330 CFS, TW ELEV = 1161.0

SINCE TW ELEV > RESERVOIR ELEVATION, TRY A LOWER Q.

FINAL ITERATION (BY TRIAL AND ERROR),

TRY Q = 2940 CFS

TW ELEV = 1159.4

CONSULTANTS,
Engineers • Geologists • Planners
Environmental Specialists

$h_d = 1160.0 - 1159.4 = \underline{0.6}$ FT

$\frac{h_d}{H} = \frac{0.6}{5.0} = 0.12$

$\therefore C_s/C = 0.68$

$\therefore Q = 0.68(4330) = \underline{2940}$ CFS. ✓

$\therefore$ AT EL. 1160.0, $Q = \underline{\underline{2940}}$ CFS. ←

HEC-1 ANALYSIS:

THE OVERTOPPING ANALYSIS WAS PERFORMED USING THE DISCHARGE RATING CURVE BASED ON NO TAILWATER INTERFERENCE. THE RESULTS OF THE ANALYSIS INDICATED THAT THE FACILITY WOULD PASS APPROXIMATELY 18 PERCENT OF THE PMF PRIOR TO OVERTOPPING AT THE BASE OF THE "BREAK" IN THE EMBANKMENT. IF THE EMBANKMENT WERE REGRADED TO THE ELEVATION OF THE TOP OF THE SPILLWAY SIDEWALLS, THE FACILITY COULD THEN PASS APPROXIMATELY 41 PERCENT OF THE PMF PRIOR TO EMBANKMENT OVERTOPPING.

HOWEVER, AS SEEN ABOVE, AT HIGH FLOWS THE TAILWATER CAUSED BY THE ROADWAY EMBANKMENT/CULVERT WILL SIGNIFICANTLY REDUCE THE DISCHARGE CAPACITY OF THE SPILLWAY. AT EL. 1160.0, THE TOP OF THE SPILLWAY SIDEWALLS, THE SPILLWAY DISCHARGE CAPACITY IS APPROXIMATELY 2940 CFS, OR ABOUT TWO-THIRDS OF THE CAPACITY WITHOUT THE TAILWATER INTERFERENCE. UNDER THESE CONDITIONS, AND ASSUMING THAT THE EMBANKMENT WERE REGRADED TO DESIGN ELEVATION, THE FACILITY COULD PASS ONLY ABOUT 28 PERCENT OF THE PMF PRIOR TO OVERTOPPING (ASSUMING THAT THE ATTENUATION OF THE PEAK INFLOW WOULD BE APPROXIMATELY THE SAME AS THE NO-TAILWATER SITUATION). FINALLY, UNDER PRESENT EXISTING CONDITIONS ("BREAK" IN EMBANKMENT, AND POTENTIAL TAILWATER INTERFERENCE), THE SPILLWAY CAN PASS APPROXIMATELY 1730 CFS, OR ABOUT 17 PERCENT OF THE PMF, PRIOR TO OVERTOPPING AT THE BASE OF THE "BREAK" IN THE EMBANKMENT.

SUBJECT DAM SAFETY INSPECTION
LAKE GREELEY DAM

BY DTS DATE 9-4-81 PROJ. NO. 80-238-252

CHKD. BY DLG DATE 9-7-81 SHEET NO. 24 OF 26

GAI CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

SEVERAL SCHEMES WERE DEVELOPED TO MODEL THE POTENTIAL FAILURE OF THE DAM UNDER EXISTING CONDITIONS. IT WAS CONCLUDED THAT IF FAILURE WERE TO OCCUR, IT WOULD BE OVER AN EXTENDED PERIOD OF TIME, DUE TO THE PRESENCE OF THE DOWNSTREAM ROADWAY EMBANKMENT AND THE TAILWATER ASSOCIATED WITH IT. THEREFORE, THE BREACH TIMES (TOTAL TIME FOR BREACH SECTION TO REACH ITS FINAL DIMENSIONS) RANGED FROM 4 TO 12 HOURS. IT WAS ALSO ASSUMED THAT FAILURE WOULD OCCUR ONLY IN THE EMBANKMENT TO THE LEFT OF THE SPILLWAY, SINCE THE "BREAK" IN THE EMBANKMENT WAS AT ITS LEFT END, AND SINCE PART OF THE DOWNSTREAM ROADWAY IN THIS VICINITY WAS LOWER THAN THE EMBANKMENT, WHILE THE PORTION OF THE ROADWAY IN FRONT OF THE EMBANKMENT TO THE RIGHT OF THE SPILLWAY WAS HIGHER ALONG ITS ENTIRE LENGTH. THE MAXIMUM PROBABLE FAILURE SECTION WAS USED TO BE CONSERVATIVE.

- BREACH BOTTOM WIDTH = 10 FT
- MAXIMUM BREACH DEPTH = 9.2 FT
  (TOP OF SPILLWAY SIDEWALLS TO BASE OF OGEE)
- TOTAL LENGTH OF BREACHABLE EMBANKMENT = 126 FT
  (LEFT SIDE ONLY)

∴ SECTION SIDE-SLOPES = 6H : 1V

(BASED ON FIELD NOTES & OBSERVATIONS)

THE BREACH ANALYSES WERE RUN UNDER 0.20PMF, 0.30PMF, AND 0.50PMF BASE FLOW CONDITIONS. IN ALL CASES, THE INCREASES IN THE DOWNSTREAM WATER LEVELS ABOVE THE NON-BREACH LEVELS WERE NOT SIGNIFICANT. THEREFORE, BASED ON THIS ANALYSIS, AND UNDER EXISTING CONDITIONS THE SPILLWAY AT LAKE GREELEY DAM IS CONSIDERED TO BE INADEQUATE, BUT NOT SERIOUSLY INADEQUATE.

THE RESULTS OF THE BREACH ANALYSES ARE PROVIDED ON SHEET 25.

SUBJECT DAM SAFETY INSPECTION
LAKE GREELEY DAM

BY DJS DATE 8-5-81 PROJ. NO. 80-238-752

CHKD. BY DLB DATE 8-7-81 SHEET NO. 25 OF 26

GAI CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

BREACH ANALYSIS OUTPUT*: (RESULTS OF 4-HOUR BREACHES ONLY)

BREACH MODEL	PEAK FLOW (CFS)	CORRESPONDING W.S. EL. (FT)	W.S.EL. W/O BREACH (FT)	ELEVATION DIFFERENCE (FT)	ESTIMATED DAMAGE ELEVATION (FT)
OUTPUT @ SECTION 1					
0.20 PMF	2368	1061.4	1060.5	+0.9	
0.30 PMF	3350	1063.3	1063.1	+0.2	1063
0.50 PMF	5888	1065.0	1064.7	+0.3	
OUTPUT @ SECTION 2					
0.20 PMF	2368	1006.3	1005.7	+0.6	
0.30 PMF	3350	1007.6	1007.3	+0.3	1010
0.50 PMF	5887	1010.3	1009.7	+0.6	
OUTPUT @ SECTION 3					
0.20 PMF	2367	937.4	937.0	+0.4	
0.30 PMF	3348	938.6	938.3	+0.3	936
0.50 PMF	5884	940.3	939.9	+0.4	
OUTPUT @ SECTION 4					
0.20 PMF	2367	919.1	918.9	+0.2	
0.30 PMF	3347	920.0	919.8	+0.2	919
0.50 PMF	5883	921.3	921.0	+0.3	

* - SEE SUMMARY INPUT/OUTPUT SHEETS, SHEETS E-L.

FINALLY, A POTENTIAL FAILURE OF THE DAM WAS ANALYZED IN WHICH THE DOWNSTREAM ROADWAY AND CULVERT WERE NOT CONSIDERED TO BE PRESENT. THE ANALYSIS WAS PERFORMED UNDER 0.45 PMF CONDITIONS. IT WAS FOUND HERE THAT FOR THE MORE RAPID BREACH TIMES (½ HR - 1 HR), THE INCREASES IN THE DOWNSTREAM WATER LEVELS ABOVE THE NON-BREACH LEVELS WOULD BE SIGNIFICANT. THEREFORE, IF THE DOWNSTREAM ROADWAY EMBANKMENT WERE NOT PRESENT, THE SPILLWAY WOULD BE CONSIDERED SERIOUSLY INADEQUATE. THE RESULTS OF THIS BREACH ANALYSIS ARE PROVIDED ON SHEET 26.

SUBJECT DAM SAFETY INSPECTION
LAKE GREELEY DAM

BY DJS DATE 8-5-81 PROJ. NO. 80-238-752
CHKD. BY DLB DATE 8-7-81 SHEET NO. 24 OF 26

GAI CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

BREACH ANALYSIS OUTPUT: (DOWNSTREAM ROADWAY NOT PRESENT)

- 0.45 PMF CONDITIONS

- MAX. SECTION: - BREACH BOTTOM WIDTH = 30 FT
  - MAX. BREACH DEPTH = 9.2 FT
  - TOTAL LENGTH OF BREACHABLE EMBANKMENT = 195 FT (LEFT AND RIGHT SIDES)
  ∴ SECTION SIDE SLOPES = 9H:1V

- AVERAGE POSSIBLE SECTION: - BREACH BOTTOM WIDTH = 15 FT
  - MAX. BREACH DEPTH = 9.2 FT
  - ASSUME 1H:1V SIDE-SLOPES

(SECTIONS BASED ON FIELD NOTES AND OBSERVATIONS)

BREACH MODEL (SECTION / BREACH TIME)	PEAK FLOW (CFS)	CORRESPONDING W.S.EL. (FT)	W.S. ELEV W/O BREACH (FT)	ELEVATION DIFFERENCE (FT)	ESTIMATED DAMAGE ELEVATION (FT)
OUTPUT @ SECTION 1					
MAX. SECTION / ½ HR	10,098	1066.7	1064.4	+2.3	1063
AVG. SECTION / 1 HR	6027	1065.1	1064.4	+0.7	
OUTPUT @ SECTION 2					
MAX. SECTION / ½ HR	9875	1012.9	1009.2	+3.7	1010
AVG. SECTION / 1 HR	6013	1010.5	1009.2	+1.3	
OUTPUT @ SECTION 3					
MAX. SECTION / ½ HR	9758	941.8	939.6	+2.2	936
AVG. SECTION / 1 HR	5956	940.3	939.6	+0.7	
OUTPUT @ SECTION 4					
MAX SECTION / ½ HR	9781	922.7	920.7	+2.0	919
AVG SECTION / 1 HR	5945	921.3	920.7	+0.6	

(- SEE SUMMARY INPUT/OUTPUT SHEETS, SHEETS M-P, PLATES 1,3.)

OVERTOPPING ANALYSIS

DAM SAFETY INSPECTION
LAKE GREELEY DAM- OVERTOPPING ANALYSIS, W/O TAILWATER CONSIDERATIONS
10-MINUTE TIME STEP AND 48-HOUR STORM DURATION

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
200	0	10	0	0	0	0	0	0	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIOS= 6 LRTIOS= 1

RTIOS= .10 .20 .30 .40 .50 1.00

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

RESERVOIR INFLOW

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
LGD	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISAME	LOCAL
1	1	7.30	0.00	7.30	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	21.50	111.00	123.00	133.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .000

INITIAL & CONSTANT RAINFALL LOSSES AS PER C.O.E.

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOR	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 2.69 CP= .45 NTA= 0

BASE FLOW PARAMETERS AS PER C.O.E.

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC=10.00 AND R=25.50 INTERVALS

UNIT HYDROGRAPH(CFS) END-OF-PERIOD ORDINATES, LAG= 2.70 HOURS, CP= .45 VOL= .97

11.	43.	89.	144.	208.	273.	338.	422.	500.	575.
640.	696.	742.	778.	803.	815.	808.	783.	753.	724.
690.	669.	644.	619.	595.	572.	550.	529.	509.	489.
470.	452.	435.	418.	402.	387.	372.	357.	344.	330.
318.	305.	294.	282.	272.	261.	251.	241.	232.	223.
215.	206.	198.	191.	183.	176.	170.	163.	157.	151.
145.	139.	134.	129.	124.	119.	115.	110.	106.	102.
98.	95.	91.	87.	84.	81.	77.	74.	72.	69.
66.	64.	61.	59.	57.	54.	52.	50.	48.	47.
45.	43.	41.	40.	38.	37.	35.	34.	33.	31.

	RAIN	EXCS	LOSS	COMP Q
SUM	24.42	22.04	2.39	506535.
	(620.)(500.)(81.)(14400.11)			

SUMMARY INPUT/OUTPUT SHEETS

SUBJECT DAM SAFETY INSPECTION
LAKE GREELEY DAM
BY JJS DATE 8-13-81 PROJ. NO. 80-238-752
CHKD. BY DAB DATE 8-13-81 SHEET NO. 1 OF 2

CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

SUBJECT DAM SAFETY INSPECTION

LAKE GREELEY DAM

BY DJS DATE 8-17-81 PROJ. NO. 80-238-252

CHKD. BY DLB DATE 8-13-81 SHEET NO. 8 OF 12

Engineers • Geologists • Planners
Environmental Specialists

CONSULTANTS, INC.

RESERVOIR INFLOW HYDROGRAPHS

0.10 PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1122.	959.	310.	176.	50617.
CMS	32.	27.	10.	5.	1434.
INCHES		1.72	1.76	1.79	1.79
MM		43.64	44.62	45.53	45.53
AC-FT		475.	887.	897.	897.
THOUS CU M		586.	847.	860.	860.

0.20 PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2385.	1918.	692.	352.	101274.
CMS	68.	54.	20.	10.	2868.
INCHES		3.44	3.53	3.58	3.58
MM		87.37	89.64	91.05	91.05
AC-FT		951.	1373.	1395.	1395.
THOUS CU M		1174.	1694.	1721.	1721.

0.30 PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3577.	2877.	1039.	527.	151911.
CMS	101.	81.	29.	15.	4302.
INCHES		5.07	5.29	5.38	5.38
MM		93.18	134.48	136.58	136.58
AC-FT		1426.	2060.	2092.	2092.
THOUS CU M		1760.	2541.	2581.	2581.

0.40 PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4769.	3836.	1385.	703.	202548.
CMS	135.	109.	39.	20.	5736.
INCHES		4.89	7.06	7.17	7.17
MM		124.15	179.29	182.11	182.11
AC-FT		1902.	2747.	2790.	2790.
THOUS CU M		2346.	3388.	3441.	3441.

0.50 PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	5962.	4794.	1731.	879.	253185.
CMS	169.	136.	49.	25.	7169.
INCHES		6.11	8.82	8.96	8.96
MM		155.18	224.11	227.63	227.63
AC-FT		2377.	3433.	3487.	3487.
THOUS CU M		2933.	4235.	4302.	4302.

PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	11921.	9589.	3462.	1758.	506371.
CMS	338.	272.	98.	50.	14339.
INCHES		12.22	17.65	17.92	17.92
MM		310.37	448.21	455.27	455.27
AC-FT		4755.	6867.	6975.	6975.
THOUS CU M		5865.	8470.	8603.	8603.

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE THROUGH RESERVOIR

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPNT	IHAME	ISTAGE	IAUTO
100	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1155.	-1

SUBJECT DAM SAFETY INSPECTION

LAKE GREELEY DAM

BY DTS DATE 8-13-81

CHKD. BY DLG DATE 8-13-81 PROJ. NO. 80-238-752

SHEET NO. C OF 2

CONSULTANTS, INC.

Engineers • Geologists • Planners
Environmental Specialists

STAGE	1155.00	1156.00	1157.00	1157.90	1158.00	1159.00	1160.00	1160.30	1160.50
	1161.00	1161.50	1162.00	1163.00	1164.00	1165.00			
FLOW	0.00	130.00	980.00	1800.00	1890.00	3070.00	4500.00	4940.00	5470.00
	6240.00	7590.00	9130.00	12540.00	16340.00	20460.00			
SURFACE AREA=	0.	72.	126.	165.	250.				
CAPACITY=	0.	290.	574.	878.	4999.				
ELEVATION=	1143.	1155.	1156.	1160.	1180.				

RATING CURVE FOR FREE DISCHARGE (NO TAILWATER).

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
1155.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
1157.9	0.0	0.0	0.

RESERVOIR OUTFLOW HYDROGRAPHS

0.10 PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	976.	858.	285.	144.	81000.
CMS	28.	24.	8.	4.	1178.
INCHES		1.09	1.45	1.47	1.47
MM		27.78	36.91	37.41	37.41
AC-FT		426.	565.	573.	573.
THOUS CU M		525.	697.	707.	707.

0.20 PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2048.	1764.	591.	297.	80218.
CMS	58.	50.	17.	8.	2441.
INCHES		2.29	3.01	3.05	3.05
MM		57.10	76.52	77.52	77.52
AC-FT		875.	1172.	1188.	1188.
THOUS CU M		1079.	1446.	1465.	1465.

0.30 PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3118.	2670.	901.	450.	131442.
CMS	88.	76.	26.	13.	3722.
INCHES		3.41	4.59	4.65	4.65
MM		86.62	116.58	118.17	118.17
AC-FT		1327.	1788.	1810.	1810.
THOUS CU M		1637.	2205.	2233.	2233.

0.40 PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4204.	3592.	1215.	615.	177201.
CMS	119.	102.	34.	17.	5018.
INCHES		4.58	6.19	6.27	6.27
MM		116.28	157.34	159.32	159.32
AC-FT		1781.	2410.	2441.	2441.
THOUS CU M		2197.	2973.	3011.	3011.

0.50 PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	5277.	4509.	1530.	774.	223042.
CFS	149.	128.	43.	22.	6316.
INCHES		5.75	7.80	7.90	7.90
MM		145.90	198.00	200.53	200.53
AC-FT		2238.	3034.	3072.	3072.
THOUS CU M		2758.	3743.	3790.	3790.

PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	11387.	9747.	3137.	1587.	457100.
CMS	322.	262.	89.	45.	12944.
INCHES		11.78	15.99	16.18	16.18
MM		299.30	406.08	410.98	410.98
AC-FT		4585.	6221.	6296.	6296.
THOUS CU M		5656.	7674.	7766.	7766.

SUBJECT DAM SAFETY INSPECTION

LAKE GREELEY DAM

BY JSS DATE 8-13-81 PROJ. NO. 80-238-752

CHKD. BY DLB DATE 8-13-81 SHEET NO. 22 OF 2

********** ********** ********** **********

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1 .10	RATIO 2 .20	RATIO 3 .30	RATIO 4 .40	RATIO 5 .50	RATIO 6 1.00
HYDROGRAPH AT	100	7.30	1	1192.	2365.	3577.	4769.	5962.	11923.
		(18.911	(	33.761(	67.022(	101.272(	135.032(	168.803(	337.603(
ROUTED TO	100	7.30	1	970.	2048.	3118.	4204.	5277.	11387.
		(18.911	(	27.471(	58.011(	88.302(	119.042(	149.431(	322.432(

SUMMARY OF DAM SAFETY ANALYSIS

	ELEVATION STORAGE OUTFLOW	INITIAL VALUE 1155.00 290. 0.	SPILLWAY CREST 1155.00 290. 0.	TOP OF DAM 1157.90 574. 1800.
RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	1156.99	0.00	408.	970.	0.00	44.17	0.00
.20	1158.11	.11	604.	2048.	3.00	44.00	0.00
.30	1159.01	1.11	725.	3118.	0.07	43.83	0.00
.40	1159.79	1.89	845.	4204.	7.50	43.83	0.00
.50	1160.50	2.60	964.	5277.	8.00	44.07	0.00
1.00	1162.66	4.76	1331.	11387.	9.33	43.17	0.00

SUMMARY OF OVERTOPPING DATA:

SPILLWAY CAPACITY	RATIO OF PMF AT WHICH OVERTOPPING OCCURS
1730 CFS	≈ 17%
2590 CFS	≈ 28%
1800 CFS	≈ 18%
9330 CFS	≈ 41%

CONDITIONS

1) EXISTING: *LOW AREA IN EMBANKMENT; TAILWATER EFFECTS INCLUDED.*
2) EMBANKMENT REGRADED: *TO EL. 1160.0; TAILWATER INCLUDED.*
3) NO TAILWATER: *ROADWAY REMOVED; LOW AREA IN EMBANKMENT.*
4) NO TAILWATER: *ROADWAY REMOVED; EMBANKMENT REGRADED TO EL. 1160.0.*

(SEE SHEETS 21-23)

CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

SUBJECT DAM SAFETY INSPECTION

LAKE GREELEY DAM

BY DSS DATE 8-13-81 PROJ. NO. 80-238-752

CHKD. BY DLG DATE 8-13-81 SHEET NO. 6 OF 12

BREACH ANALYSIS
(INPUT SAME AS FOR OVERTOPPING ANALYSIS, WITH THE ADDITION OF BREACH DATA GIVEN HERE.)

BREACH OUTFLOW HYDROGRAPHS (RESULTS OF 4-HOUR BREACHES)

0.20PMF

```
DAM SAFETY INSPECTION
LAKE GREELEY DAM- BREACH ANALYSIS III
10-MINUTE TIME STEP AND 48-HOUR STORM DURATION

                    JOB SPECIFICATION
  NQ     NHR     NMIN     IDAY     JHR     JMIN    METRC     IPLT     IPRT    NSTAN
 288       0       10        0       0        0        0        0        0        0
                          JUPER      NWT   LKOPT    TRACE
                              5        0       0        0

**********      **********      **********      **********      **********

                    HYDROGRAPH ROUTING

  ROUTE THROUGH RESERVOIR

                        DAM DATA
                  IUPEL     CUOD     EXPD   DAMWID
                 1157.9      0.0      0.0       0.

                    DAM BREACH DATA
                BRWID        Z     ELBM    TFAIL     WSEL   FAILEL
                  10.     6.00  1150.80     4.00  1155.00  1157.90

BEGIN DAM FAILURE AT 42.67 HOURS

PEAK OUTFLOW IS     2371. AT TIME  45.58 HOURS

                    PEAK    6-HOUR   24-HOUR   72-HOUR   TOTAL VOLUME
          CFS       2371.    2062.     668.     338.        97253.
          CMS         67.      58.      19.      10.         2754.
       INCHES                 2.63     3.40     3.44         3.44
           MM                66.76    86.44    87.44        87.44
        AC-FT                1023.    1324.    1340.        1340.
    THOUS CU M               1262.    1634.    1652.        1652.
```

0.30PMF

```
                    DAM BREACH DATA
                BRWID        Z     ELBM    TFAIL     WSEL   FAILEL
                  10.     6.00  1150.80     4.00  1155.00  1158.90

BEGIN DAM FAILURE AT 41.00 HOURS

PEAK OUTFLOW IS     3354. AT TIME  44.67 HOURS

                    PEAK    6-HOUR   24-HOUR   72-HOUR   TOTAL VOLUME
          CFS       3354.    3010.     989.     500.       144097.
          CMS         95.      85.      28.      14.         4080.
       INCHES                 3.84     5.04     5.10         5.10
           MM                97.44   128.06   129.55       129.55
        AC-FT                1493.    1962.    1985.        1985.
    THOUS CU M               1841.    2420.    2448.        2448.
```


CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

SUBJECT DAM SAFETY INSPECTION

LAKE GREELEY DAM

BY ZDS DATE 8-13-81 PROJ. NO. 80-238-252

CHKD. BY DLB DATE 8-13-81 SHEET NO. 5 OF 2

Engineers • Geologists • Planners
Environmental Specialists

CONSULTANTS, INC.

0.50PMF

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	MSEL	FAILEL
10.	0.00	1150.00	4.00	1155.00	1160.00

STATION SGD . PLAN 1, RATIO 1

BEGIN DAM FAILURE AT 42.33 HOURS

PEAK OUTFLOW IS 5894. AT TIME 44.25 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	5894.	4998.	1651.	835.	240514.
CMS	167.	142.	47.	24.	6811.
INCHES		6.37	8.42	8.51	8.51
MM		161.79	213.77	216.24	216.24
AC-FT		2479.	3275.	3313.	3313.
THOUS CU M		3057.	4040.	4086.	4086.

DOWNSTREAM ROUTING DATA:

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE THROUGH SYLVANIA LAKE DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
SLD 1		0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1070.	0

SURFACE AREA=	0.	10.	14.	31.	94.
CAPACITY=	0.	20.	46.	221.	1414.
ELEVATION=	1064.	1070.	1072.	1080.	1100.

CREL	SPWID	COOM	EXPW	ELEVL	COOL	CAREA	EXPL
1070.0	40.0	3.6	1.5	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
1072.0	0.0	0.0	0.

CREST LENGTH	100.	300.	600.
AT OR BELOW ELEVATION	1072.0	1080.0	1100.0

CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE FROM SYLVANIA LAKE TO SECTION 1@ 7350 FT D.S. FROM LAKE GREELEY DAM

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
SEC1	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

			IRES	ISAME	IOPT	IPMP		LSTR
QLOSS	CLOSS	AVG	1	1	0	0		0
0.0	0.000	0.00						
	NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
	1	0	0	0.000	0.000	0.000	-1.	0

NORMAL DEPTH CHANNEL ROUTING:

QN(1)	QN(2)	QN(3)	ELMVI	ELMAX	MLNTH	SEL
.0700	.0450	.0700	1053.0	1080.0	800.	.02400

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 1080.00 150.00 1063.00 300.00 1063.00 300.00 1053.00 320.00 1053.00
320.00 1063.00 410.00 1070.00 550.00 1080.00

STORAGE	0.00	.52	1.04	1.57	2.09	2.61	3.13	3.65	8.32
	20.35	27.57	35.59	44.45	54.15	64.69	76.08	88.32	101.40
	0.00	168.65	495.17	907.51	1375.89	1883.60	2420.21	2978.74	4591.37
OUTFLOW	11691.68	17050.24	23657.74	31540.28	40819.43	51539.56	63777.82	77603.38	93085.00
	1053.00	1054.42	1055.84	1057.26	1058.68	1060.11	1061.53	1062.95	1064.37
STAGE	1067.21	1068.63	1070.05	1071.47	1072.89	1074.32	1075.74	1077.16	1078.58
	0.00	168.65	495.17	907.51	1375.89	1883.60	2420.21	2978.74	4591.37
FLOW	11691.68	17050.24	23657.74	31540.28	40819.43	51539.56	63777.82	77603.38	93085.00

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE FROM SECTION 1 TO SECTION 2@ 9650 FT D.S. FROM LAKE GREELEY DAM

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
SEC2	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

			IRES	ISAME	IOPT	IPMP		LSTR
QLOSS	CLOSS	AVG	1	1	0	0		0
0.0	0.000	0.00						
	NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
	1	0	0	0.000	0.000	0.000	-1.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELMVI	ELMAX	MLNTH	SEL
.0800	.0450	.0800	1000.0	1040.0	2300.	.02600

SUBJECT DAM SAFETY INSPECTION
LAKE GREELEY DAM
BY TJS DATE 8/17/81 PROJ. NO. 80-228-252
CHK'D. BY DHB DATE 8/13-81 SHEET NO. 4 OF 2

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 1040.00 80.00 1020.00 160.00 1010.00 170.00 1000.00 190.00 1000.00
200.00 1010.90 380.00 1020.00 520.00 1040.00

STORAGE	0.00	2.46	5.38	8.78	12.64	17.14	26.15	41.25	62.42
	122.60	150.52	197.02	238.09	281.73	327.95	376.74	428.11	482.05
OUTFLOW	0.00	366.71	1180.55	2378.95	3963.09	6065.52	9260.08	13793.58	20088.32
	39796.97	53992.00	70611.89	89679.48	111235.67	135331.97	162026.40	191381.09	223460.81
STAGE	1000.00	1002.11	1004.21	1006.32	1008.42	1010.53	1012.63	1014.74	1016.84
	1021.05	1023.15	1025.26	1027.37	1029.47	1031.58	1033.68	1035.79	1037.89
FLOW	0.00	366.71	1180.55	2378.95	3963.09	6065.52	9260.08	13793.58	20088.32
	39796.97	53992.00	70611.89	89679.48	111235.67	135331.97	162026.40	191381.09	223460.81

****

HYDROGRAPH ROUTING

ROUTE FROM SECTION 2 SECTION 3; 12430 FT D.S. FROM LAKE GREELEY DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
SEC3	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP		LSTR
0.0	0.000	0.00	1	1	0	0		0
	NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPHAT
	1	0	0	0.000	0.000	0.000	-1.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELMVT	ELMAX	RLNTH	SEL
.0800	.0450	.1000	929.0	960.0	2780.	.01800

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 960.00 110.00 940.00 300.00 936.00 300.00 929.00 320.00 929.00
320.00 936.00 370.00 940.00 420.00 960.00

STORAGE	0.00	2.08	4.17	6.25	8.33	12.98	27.39	51.71	79.81
	140.09	172.27	205.81	240.71	276.97	314.59	353.57	393.90	435.60
OUTFLOW	0.00	181.65	528.37	961.24	1448.67	2128.95	3491.78	6102.00	10334.76
	22265.78	29848.09	38472.60	48128.19	58810.90	70521.69	83265.08	97048.17	111880.02
STAGE	929.00	930.63	932.26	933.89	935.53	937.16	938.79	940.42	942.05
	945.32	946.95	948.58	950.21	951.84	953.47	955.11	956.74	958.37
FLOW	0.00	181.65	528.37	961.24	1448.67	2128.95	3491.78	6102.00	10334.76
	22265.78	29848.09	38472.60	48128.19	58810.90	70521.69	83265.08	97048.17	111880.02

CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE FROM SECTION 2 TO SECTION 4; 13400 FT D.S. FROM LAKE GREELEY DAM

	ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
	SEC4	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

	QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP		LSTR
	0.0	0.000	0.00	1	1	0	0		0
		NSTPS	NSTOL	LAG	AMSKK	X	TSK	STORA	ISPRAT
		1	0	0	0.000	0.000	0.000	-1.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNV1	ELMAX	RLNTH	SEL
.0800	.0450	.0800	913.0	940.0	970.	.01500

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 940.00 300.00 920.00 416.00 917.00 420.00 913.00 440.00 913.00
444.00 917.00 550.00 920.00 1250.00 940.00

STORAGE	0.00	.68	1.45	2.36	5.52	12.02	21.22	32.67	46.37
	80.51	100.95	123.64	148.59	175.77	205.21	236.90	270.83	307.01
OUTFLOW	0.00	144.57	460.76	930.86	1812.59	3505.03	6374.51	10465.18	15915.13
	31442.78	41786.33	54020.27	68267.79	84648.66	103279.53	124274.23	147743.94	173797.67
STAGE	913.00	914.42	915.84	917.26	918.68	920.11	921.53	922.95	924.37
	927.21	928.63	930.05	931.47	932.89	934.32	935.74	937.16	938.58
FLOW	0.00	144.57	460.76	930.86	1812.59	3505.03	6374.51	10465.18	15915.13
	31442.78	41786.33	54020.27	68267.79	84648.66	103279.53	124274.23	147743.94	173797.67

********** ********** ********** ********** **********

BREACH ANALYSIS OUTPUT SUMMARY:

SUMMARY OF DAM SAFETY ANALYSIS

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1155.00	1155.00	1157.90
STORAGE	290.	290.	574.
OUTFLOW	0.	0.	1000.

LAKE GREELEY DAM

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS	
.20	1158.11	.21	601.	2371.	2.25	45.50	42.67	- 4-HOUR BREACH
.20	1158.13	.23	604.	2048.	3.00	44.00	0.00	- NON-BREACH

SUBJECT DAM SAFETY INSPECTION

LAKE GREELEY DAM

BY DSS DATE 6-12-81

CHKD. BY DLG DATE 8-13-81 PROJ. NO. 80-238-752

SHEET NO. 7 OF 12

CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

SUBJECT: DAM SAFETY INSPECTION

LAKE GREELEY DAM

BY DJS DATE 8-13-81 PROJ. NO. 80-238-752

CHKD. BY DAS DATE 8-13-81 SHEET NO. 7 OF 12

GEI CONSULTANTS, INC.

Engineers • Geologists • Planners
Environmental Specialists

LAKE GREELEY DAM

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS	
.30	1159.01	1.11	724.	3354.	4.92	44.67	43.00	- 4-HR BREACH
.30	1159.03	1.13	726.	3119.	6.67	43.83	0.00	- NON-BREACH

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS	
.50	1160.35	2.45	936.	5694.	6.58	44.25	42.33	- 4 HR BREACH
.50	1160.50	2.60	952.	5277.	8.00	43.67	0.00	- NON-BREACH

****

ROUTE THROUGH SYLVANIA LAKE DAM

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1070.00	1070.00	1072.00
STORAGE	20.	20.	44.
OUTFLOW	0.	0.	407.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS	
.20	1074.14	2.14	78.	2360.	8.17	45.67	0.00	- 4 HR. BREACH
.20	1073.89	1.89	76.	2045.	9.17	44.17	0.00	- NON-BREACH

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS	
.30	1074.81	2.81	91.	3351.	9.17	44.83	0.00	- 4 HR BREACH
.30	1074.66	2.66	88.	3113.	9.17	44.00	0.00	- NON-BREACH

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS	
.50	1076.19	4.19	126.	5088.	10.67	44.33	0.00	- 4 HR BREACH
.50	1075.88	3.88	113.	5272.	10.67	43.83	0.00	- NON-BREACH

SUBJECT DAM SAFETY INSPECTION

LAKE GREELEY DAM

BY DJS DATE 8-14-81 PROJ. NO. 80-238-752

CHKD. BY DLB DATE 8-14-81 SHEET NO. K OF P

CONSULTANTS, INC

Engineers • Geologists • Planners
Environmental Specialists

SECTION 1

PLAN 1 STATION SEC1

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS	
.20	2368.	1061.4	45.67	- 4-HR BREACH
.20	2045.	1060.9	44.17	- NON-BREACH

PLAN 1 STATION SEC1

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS	
0.30	3350	1063.3	44.83	-4-HR BREACH
.30	3113.	1063.1	44.00	- NON-BREACH

PLAN 1 STATION SEC1

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS	
0.50	5888.	1065.0	44.33	- 4-HR BREACH
.50	5271.	1064.7	43.83	- NON-BREACH

SECTION 2

PLAN 1 STATION SEC2

	RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
4-HR BREACH -	.20	2368.	1006.3	45.83
NON-BREACH -	.20	2045.	1005.7	44.17

PLAN 1 STATION SEC2

	RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
4-HR BREACH -	.30	3350.	1007.6	44.83
NON-BREACH -	.30	3113.	1007.3	44.00

PLAN 1 STATION SEC2

	RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
4-HR BREACH -	.50	5887.	1010.2	44.33
NON-BREACH -	.50	5270.	1009.7	44.00

SUBJECT DAM SAFETY INSPECTION

LAKE GREELEY DAM

BY DTS DATE 8-14-81 PROJ. NO. 80-232-252

CHK'D. BY DLA DATE 8-14-81 SHEET NO. 4 OF 2

GEI CONSULTANTS, INC.

Engineers • Geologists • Planners
Environmental Specialists

SECTION 3

PLAN 1 STATION SEC3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS	
.20	2367.	937.4	45.83	- 4-HR BREACH
.20	2044.	937.0	44.17	- NON-BREACH

PLAN 1 STATION SEC3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS	
.30	3348.	938.6	45.00	- 4-HR BREACH
.30	3110.	938.3	44.17	- NON-BREACH

PLAN 1 STATION SEC3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS	
.50	5884.	940.3	44.50	-4-HR BREACH
.50	5268.	939.9	44.00	- NON-BREACH

SECTION 4

4-HR BREACH -
NON-BREACH -

PLAN 1 STATION SEC4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.20	2367.	919.1	46.00
.20	2044.	918.9	44.33

PLAN 1 STATION SEC4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.30	3347.	920.0	45.17
.30	3108.	919.8	44.17

4-HR BREACH -
NON-BREACH -

PLAN 1 STATION SEC4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	5883.	921.3	44.50
.50	5266.	921.0	44.00

4-HR BREACH -
NON-BREACH -

SUBJECT: DAM SAFETY INSPECTION
LAKE GREELEY DAM

BY: DJS DATE: 8-14-81 PROJ. NO. 80-238-752
CHKD. BY: DLB DATE: 8-14-81 SHEET NO. M OF P

GAI CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

BREACH ANALYSIS W/DOWNSTREAM ROADWAY NOT PRESENT. (0.45 PMF CONDITIONS).

BREACH OUTFLOW HYDROGRAPHS

```
DAM SAFETY INSPECTION
LAKE GREELEY DAM- BREACH ANALYSIS II
10-MINUTE TIME STEP AND 48-HOUR STORM DURATION
                         JOB SPECIFICATION
  NQ     NHR    NMIN    IDAY    IHR    IMIN   METRC    IPLT    IPRT   NSTAN
 288       0      10       0      0       0       0       0       0       0
                        JOPER    NWT   LROPT   TRACE
                           5       0       0       0

              MULTI-PLAN ANALYSES TO BE PERFORMED
                NPLAN= 4 NRTIO= 1 LRTIO= 1
  RTIOS=   .45

**********    **********    **********    **********    **********

                       HYDROGRAPH ROUTING
  ROUTE THROUGH RESERVOIR

                         DAM DATA
                TOPEL    COQD    EXPD   DAMWID
               1157.9     0.0     0.0       0.
```

PLAN 1

```
                       DAM BREACH DATA
  BRWID      Z     ELBM    TFAIL     WSEL   FAILEL
    30.   9.00  1150.80      .50  1155.00  1160.00

               STATION  LGD  , PLAN 1, RATIO 1

BEGIN DAM FAILURE AT 43.00 HOURS
PEAK OUTFLOW IS    11063. AT TIME  43.50 HOURS

                  PEAK   6-HOUR   24-HOUR   72-HOUR   TOTAL VOLUME
        CFS     11063.    4708.     1542.      769.        224528.
        CMS       313.     135.       44.       22.          6358.
     INCHES               6.08      7.86      7.95          7.95
         MM             154.32    199.64    201.87        201.87
      AC-FT              2364.     3059.     3093.         3093.
   THOUS CU M            2916.     3773.     3815.         3815.
```

PLAN 2

```
                       DAM BREACH DATA
  BRWID      Z     ELBM    TFAIL     WSEL   FAILEL
    30.   9.00  1150.80     4.00  1155.00  1160.00

               STATION  LGD  , PLAN 2, RATIO 1

BEGIN DAM FAILURE AT 43.00 HOURS
PEAK OUTFLOW IS     5366. AT TIME  44.50 HOURS

                  PEAK   6-HOUR   24-HOUR   72-HOUR   TOTAL VOLUME
        CFS      5366.    4659.     1529.      773.        222580.
        CMS       152.     132.       43.       22.          6303.
     INCHES               5.94      7.79      7.88          7.88
         MM             150.81    197.89    200.12        200.12
      AC-FT              2310.     3032.     3066.         3066.
   THOUS CU M            2850.     3740.     3782.         3782.
```

SUBJECT DAM SAFETY INSPECTION

LAKE GREELEY DAM

BY DSK DATE 8-14-81 PROJ. NO. 80-238-752

CHKD. BY DLG DATE 8-14-81 SHEET NO. N OF P

CONSULTANTS, INC.

Engineers • Geologists • Planners
Environmental Specialists

PLAN 3.

LAKE GREELEY DAM

DAM BREACH DATA

BRWID	Z	ELDM	TRAIL	WSEL	FAILEL
15.	1.00	1150.80	1.00	1155.00	1160.00

STATION DGD , PLAN 3, RATIO 1

BEGIN DAM FAILURE AT 43.00 HOURS

PEAK OUTFLOW IS 6184. AT TIME 44.00 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	6184.	4343.	1444.	731.	210401.
CMS	175.	123.	41.	21.	5958.
INCHES		5.53	7.36	7.45	7.45
MM		140.56	186.94	189.17	189.17
AC-FT		2153.	2864.	2898.	2898.
THOUS CU M		2656.	3533.	3575.	3575.

********** ********** ********** ********** **********

OUTPUT SUMMARY:

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ***************

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1155.00	1155.00	1157.90
STORAGE	290.	290.	574.
OUTFLOW	0.	0.	1800.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.45	1160.05	2.15	887.	11063.	5.89	43.50	43.00

PLAN 2 ***************

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1155.00	1155.00	1157.90
STORAGE	290.	290.	574.
OUTFLOW	0.	0.	1800.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.45	1160.09	2.19	893.	5300.	5.92	44.50	43.00

PLAN 3 ***************

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1155.00	1155.00	1157.90
STORAGE	290.	290.	574.
OUTFLOW	0.	0.	1800.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.45	1160.10	2.20	895.	6184.	6.90	44.00	43.00

SUBJECT DAM SAFETY INSPECTION

LAKE GREELEY DAM

BY RJS DATE 8-14-81 PROJ. NO. 80-238-752

CHKD. BY DLB DATE 8-14-81 SHEET NO. 2 OF 2

GEI CONSULTANTS, INC.

Engineers • Geologists • Planners
Environmental Specialists

SYLVANIA LAKE DAM

PLAN 4 .....
(NON-BREACH)

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1155.00	1155.00	1157.90
STORAGE	290.	290.	574.
OUTFLOW	0.	0.	1800.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.45	1160.16	2.26	906.	4726.	7.67	43.83	0.00
**********	**********	**********	**********	**********	**********	**********	

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1070.00	1070.00	1072.00
STORAGE	20.	20.	44.
OUTFLOW	0.	0.	407.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.45	1077.91	5.91	161.	10071.	10.33	43.67	0.00

PLAN 2 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1070.00	1070.00	1072.00
STORAGE	20	20.	44.
OUTFLOW	0.	0.	407.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.45	1075.91	3.91	114.	5360.	10.33	44.67	0.00

PLAN 3 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1070.00	1070.00	1072.00
STORAGE	20.	20.	44.
OUTFLOW	0.	0.	407.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.45	1076.25	4.25	121.	6020.	10.33	44.17	0.00

PLAN 4 .....
(NON-BREACH)

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1070.00	1070.00	1072.00
STORAGE	20.	20.	44.
OUTFLOW	0.	0.	407.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.45	1075.60	3.60	107.	4723.	10.33	43.83	0.00

SUBJECT DAM SAFETY INSPECTION

LAKE GREELEY DAM

BY JJS DATE 8-14-81 PROJ. NO. 80-238-752

CHKD. BY DLA DATE 8-14-81 SHEET NO. 2 OF 2

CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

SECTION 1

PLAN 1 STATION SEC1

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.45	10097.	1066.7	43.67

PLAN 2 STATION SEC1

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.45	5360.	1064.7	44.67

PLAN 3 STATION SEC1

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.45	8027.	1065.1	44.17

PLAN 4 (NON-BREACH) STATION SEC1

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.45	4723.	1064.4	44.00

SECTION 2

PLAN 1 STATION SEC2

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.45	9879.	1012.9	43.67

PLAN 2 STATION SEC2

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.45	5359.	1009.8	44.67

PLAN 3 STATION SEC2

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.45	8013.	1010.5	44.17

PLAN 4 (NON-BREACH) STATION SEC2

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.45	4724.	1009.2	44.00

SECTION 3

PLAN 1 STATION SEC3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.45	9758.	941.8	43.83

PLAN 2 STATION SEC3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.45	5358.	940.8	44.83

PLAN 3 STATION SEC3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.45	5956.	940.3	44.33

PLAN 4 (NON-BREACH) STATION SEC3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.45	4719.	939.6	44.00

SECTION 4

PLAN 1 STATION SEC4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.45	9721.	922.7	43.83

PLAN 2 STATION SEC4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.45	5359.	921.8	44.83

PLAN 3 STATION SEC4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.45	5945.	921.3	44.33

PLAN 4 (NON-BREACH) STATION SEC4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.45	4719.	920.7	44.17

LIST OF REFERENCES

1. "Recommended Guidelines for Safety Inspection of Dams," prepared by Department of the Army, Office of the Chief of Engineers, Washington, D. C. (Appendix D).

2. "Unit Hydrograph Concepts and Calculations," by the U. S. Army, Corps of Engineers, Baltimore District (L-519).

3. "Seasonal Variation of Probable Maximum Precipitation East of the 105th Meridian for Areas from 10 to 1,000 Square Miles and Durations of 6, 12, 24, and 48 Hours," Hydrometeorological Report No. 33, prepared by J. T. Reidel, J. F. Appleby and R. W. Schloemer, Hydrologic Service Division, Hydrometeorological Section, U. S. Army, Corps of Engineers, Washington, D. C., April 1956.

4. Design of Small Dams, U. S. Department of the Interior, Bureau of Reclamation, Washington, D. C., 1973.

5. Handbook of Hydraulics, H. W. King, and E. F. Brater, McGraw-Hill, Inc., New York, 1963.

6. Standard Handbook for Civil Engineers, F. S. Merritt, McGraw-Hill, Inc., New York, 1963.

7. Open-Channel Hydraulics, V. T. Chow, McGraw-Hill, Inc., New York, 1959.

8. Weir Experiments, Coefficients, and Formulas, R. E. Horton, Water Supply and Irrigation Paper No. 200, Department of the Interior, United States Geological Survey, Washington, D. C., 1907.

9. "Probable Maximum Precipitation, Susquehanna River Drainage Above Harrisburg, Pennsylvania," Hydrometerological Report No. 40, prepared by H. V. Goodyear and J. T. Riedel, Hydrometeorological Branch Office of Hydrology, U. S. Weather Bureau, U. S. Department of Commerce, Washington, D. C., May, 1965.

10. Flood Hydrograph Package (HEC- 1) Dam Safety Version, Hydrologic Engineering Center, U. S. Army, Corps of Engineers, Davis, California, July 1978.

11. "Simulation of Flow Through Broad Crest Navigation Dams with Radial Gates," R. W. Schmitt, U. S. Army, Corps of Engineers, Pittsburgh District.

12. "Hydraulics of Bridge Waterways," BPR, 1970, Discharge Coefficient Based on Criteria for Embankment Shaped Weirs, Figure 24, page 46.

13. Applied Hydraulics in Engineering, H. M. Morris and J. N. Wiggert, Virginia Polytechnic Institute and State University, 2nd Edition, The Ronald Press Company, New York, 1972.

14. Standard Mathematical Tables, 21st Edition, The Chemical Rubber Company, 1973, page 15.

15. Engineering Field Manual, U. S. Department of Agriculture, Soil Conservation Service, 2nd Edition, Washington, D. C., 1969.

16. Water Resources Engineering, R. K. Linsley and J. B. Franzini, McGraw-Hill, Inc., New York, 1972.

17. Engineering for Dams, Volume 2, W. P. Creager, J. D. Justin, J. Hinds, John Wiley & Sons, Inc., New York, 1964.

18. Roughness Characteristics of Natural Channels, H. H. Barnes, Jr., Geological Survey Water-Supply Paper 1849, Department of the Interior, United States Geological Survey, Arlington, Virginia, 1967.

19. "Hydraulic Charts for the Selection of Highway Culverts," Hydraulic Engineering Circular No. 5, Bureau of Public Roads, Washington, D. C., 1965.

APPENDIX E

FIGURES

LIST OF FIGURES

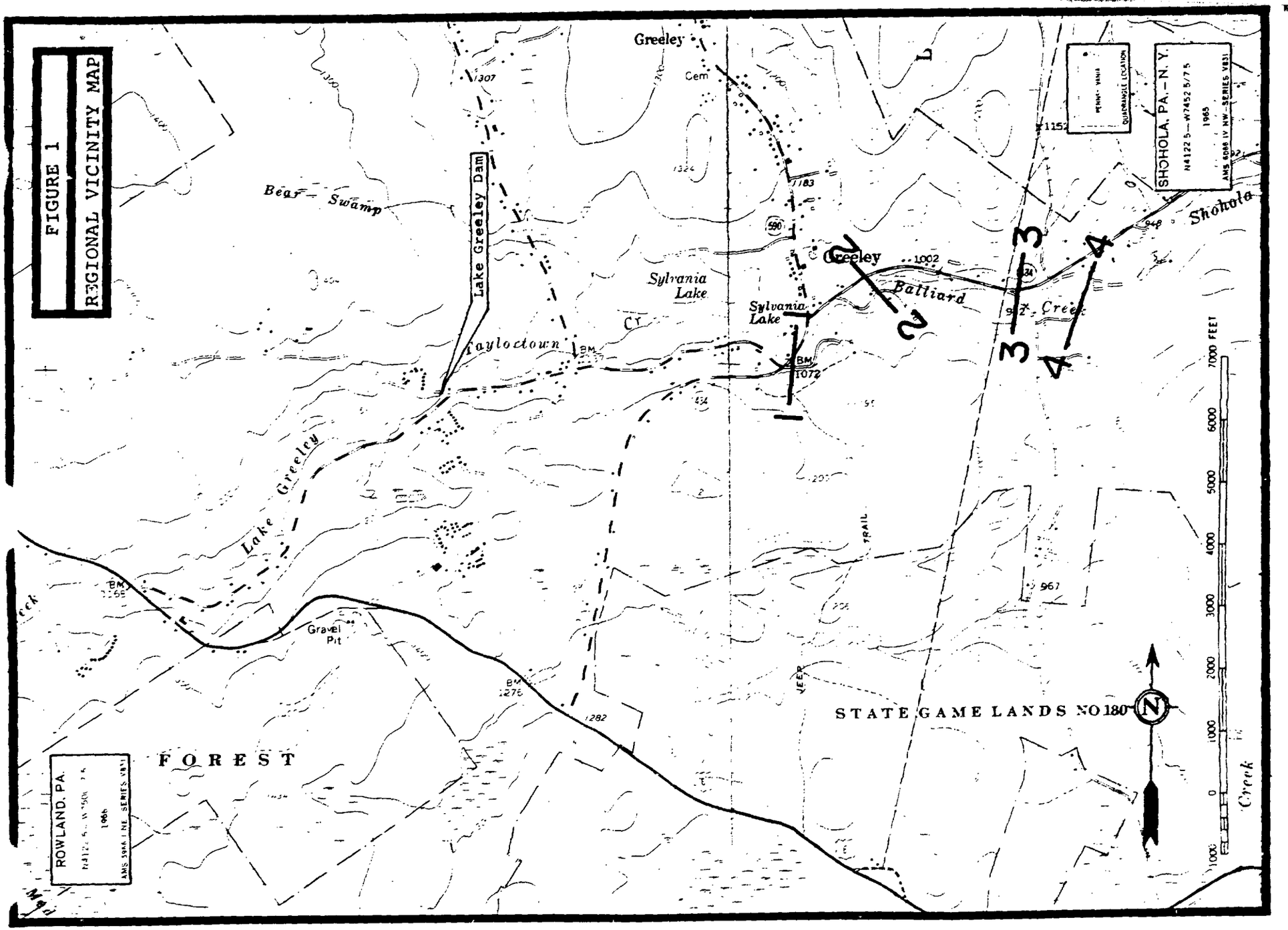


FIGURE 1
REGIONAL VICINITY MAP
Greeley
Cem
Bear Swamp
Lake Greeley Dam
Sylvania Lake
Taylorctown
BM
1072
Greeley
1002
Balliard
Creek
Sylvania Lake
Shohola
Lake Greeley
Gravel Pit
BM
1275
1282
TRAIL
JEEP
967
STATE GAME LANDS NO 180
FOREST
Creek
7000 FEET
6000
5000
4000
3000
2000
1000
0
1000
ROWLAND, PA.
1966
SHOHOLA, PA.—N. Y.
1965
QUADRANGLE LOCATION

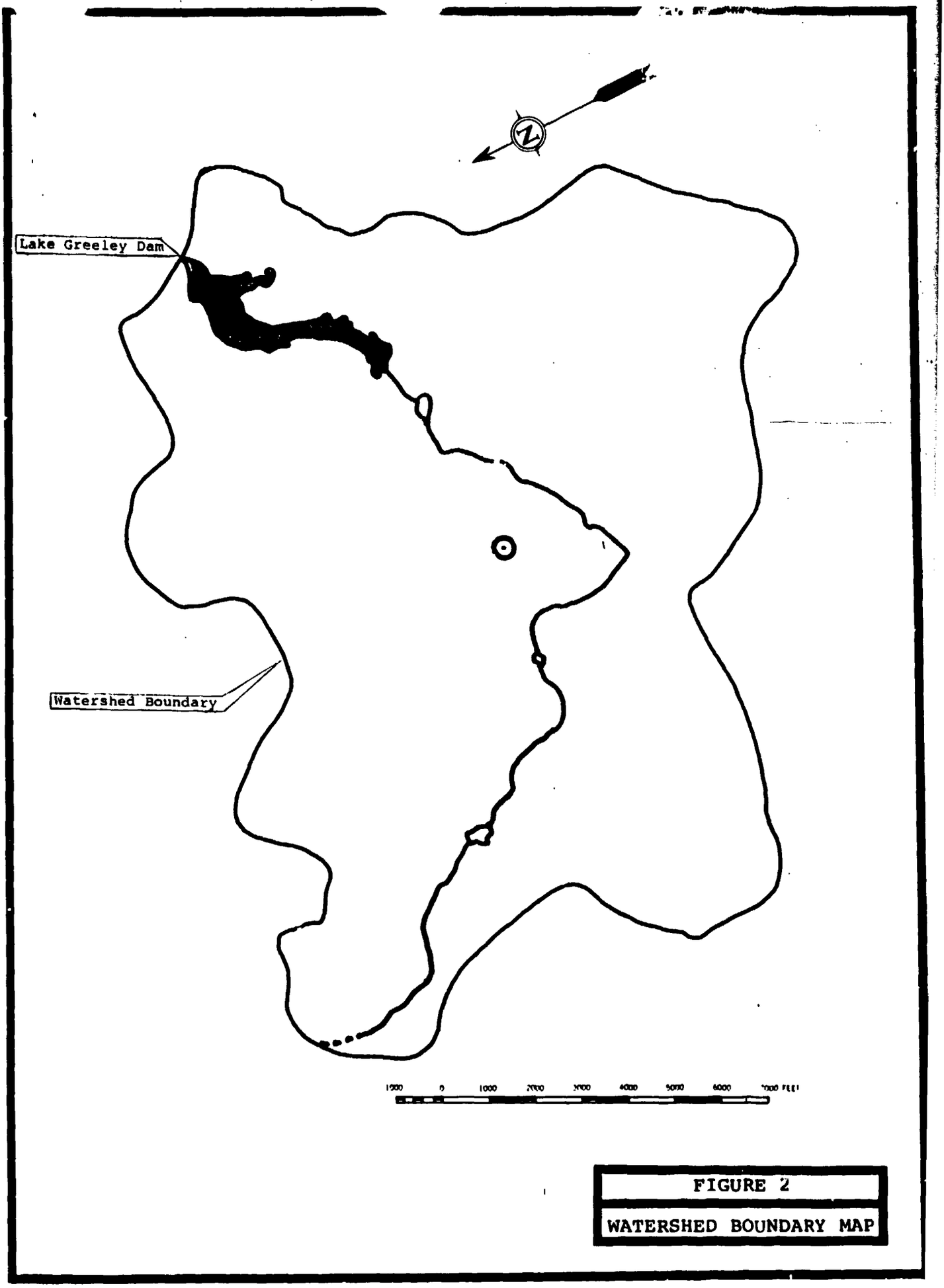
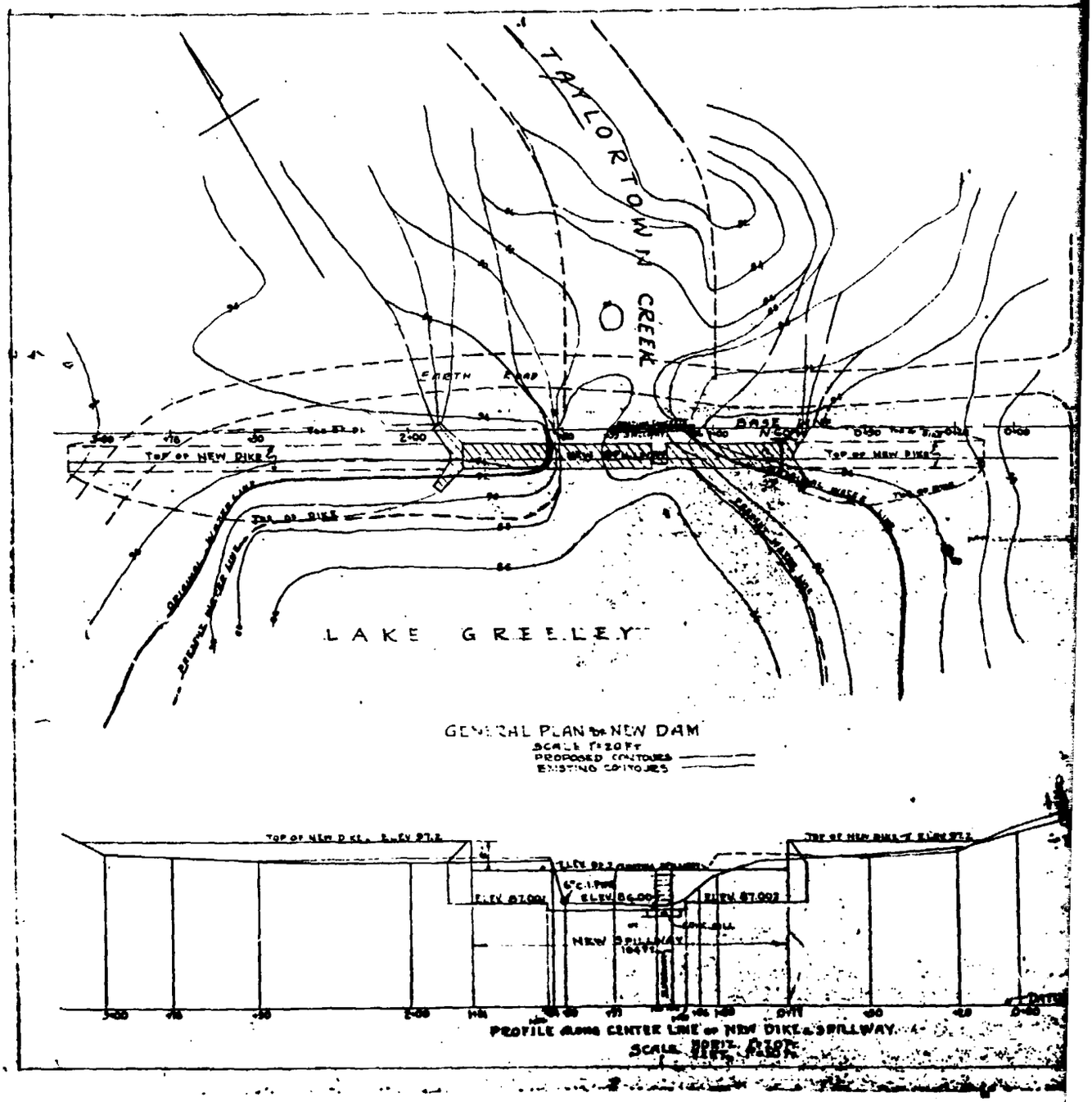
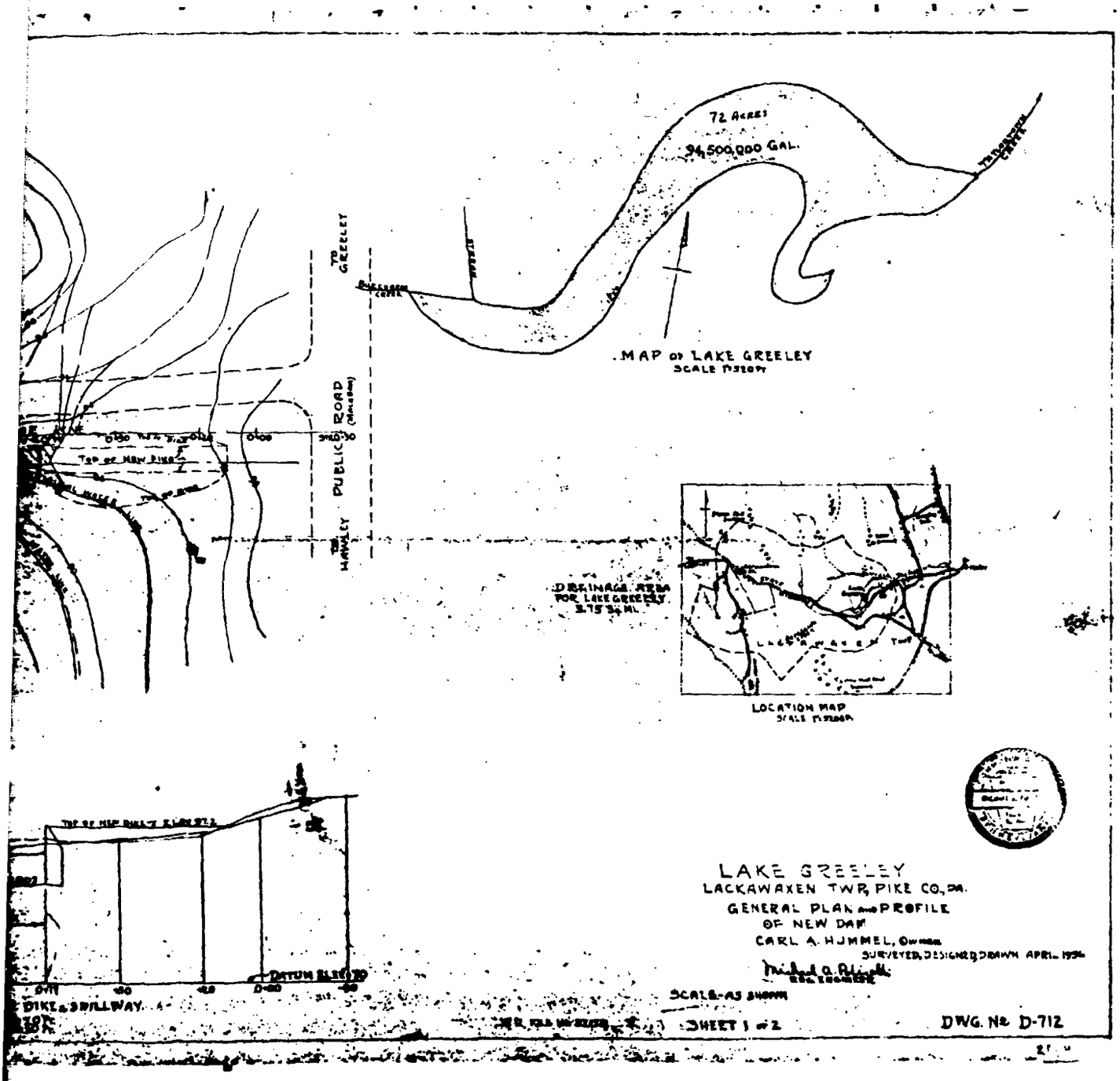


FIGURE 2

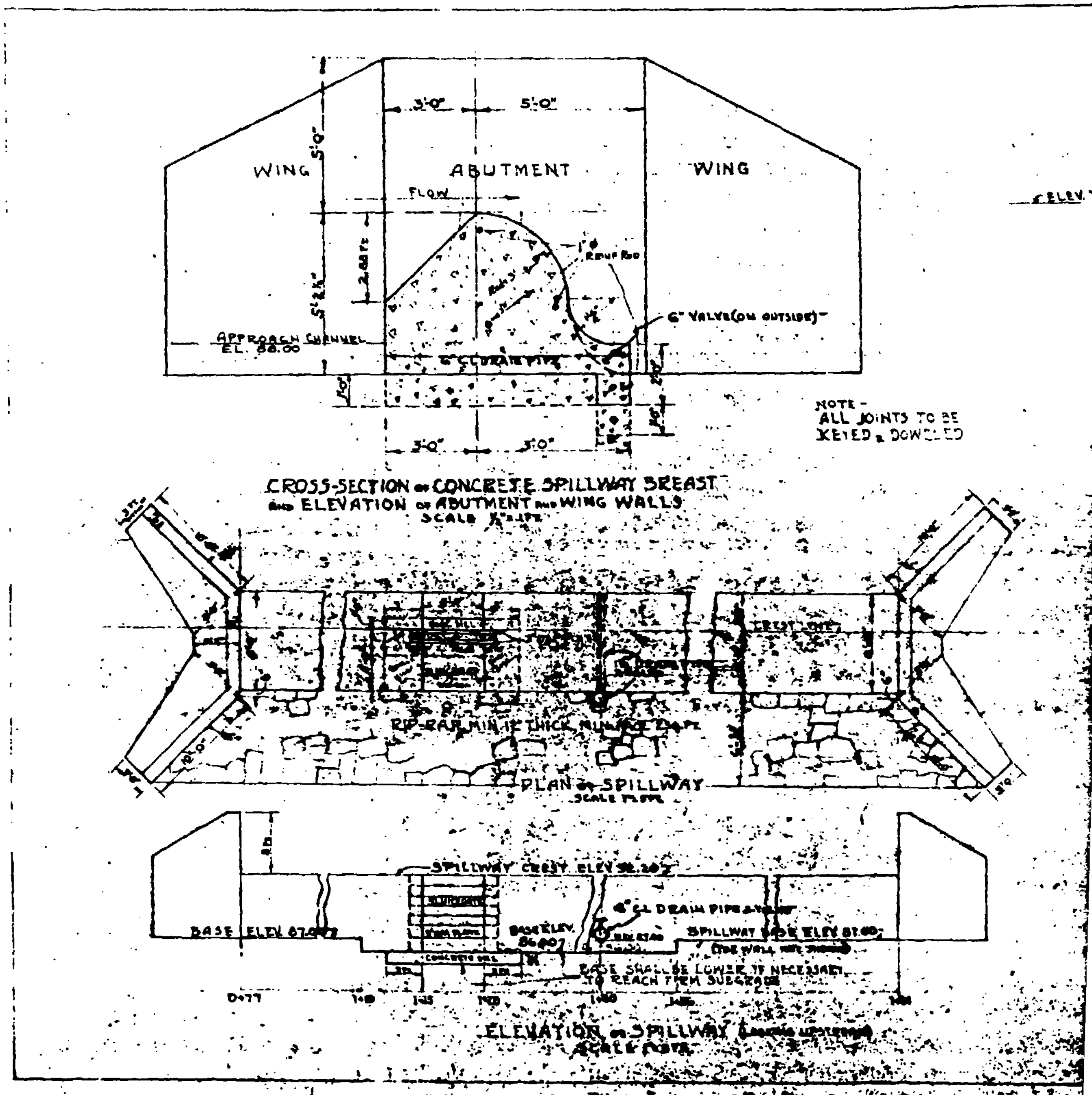
WATERSHED BOUNDARY MAP

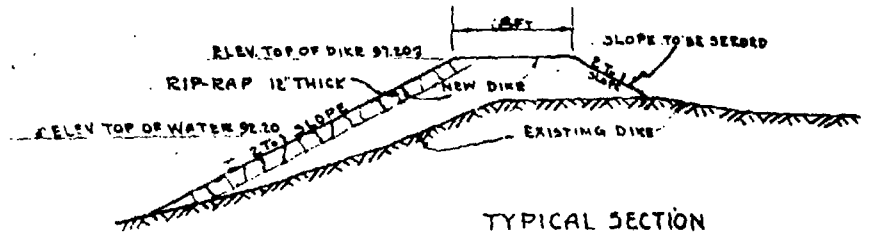

TAYLORTOWN CREEK
EARTH ROAD
TOP OF NEW DIKE
TOP OF DIKE
LAKE GREELEY
GENERAL PLAN of NEW DAM
SCALE 1"=20 Ft
PROPOSED CONTOURS
EXISTING CONTOURS
TOP OF NEW DIKE
6"C.I. PIPE
NEW SPILLWAY
PROFILE along CENTER LINE of NEW DIKE & SPILLWAY



GAI CONSULTANTS, INC.

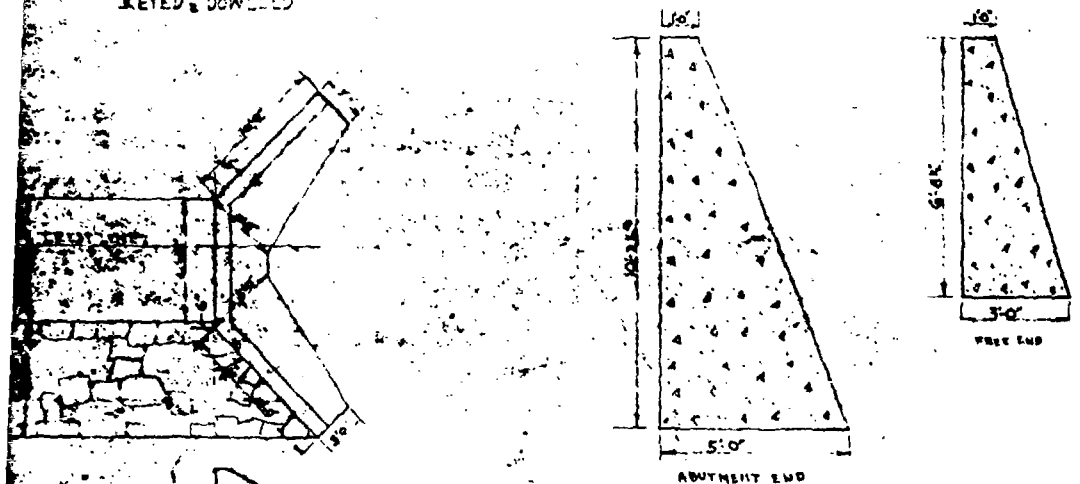
FIGURE 3


WING
ABUTMENT
WING
FLOW
3'-0"
5'-0"
APPROACH CHANNEL
6" VALVE (ON OUTSIDE)
NOTE -
ALL JOINTS TO BE
KEYED & DOWELED
CROSS-SECTION OF CONCRETE SPILLWAY BREAST
AND ELEVATION OF ABUTMENT AND WING WALLS
PLAN OF SPILLWAY
ELEVATION OF SPILLWAY



TYPICAL SECTION
OF EMBANKMENT
SCALE 1"=5 Ft

NOTE -
ALL JOINTS TO BE
KEYED & DOWELED



CROSS-SECTION OF WING WALL
SCALE 1/4"=1Ft

LAKE GREELEY
LACKAWAXEN TWP, PIKE CO., PA
CONCRETE SPILLWAY DETAILS
OF NEW DAM
CARL A. HUMMEL, Owner
SURVEYED, DESIGNED, DRAWN APRIL 1956
Michael A. Palmieri
REG. ENGINEER
SCALE-AS SHOWN
WD. FILE NO. 5568
SHEET 2 of 2
DWG. NO. D-712

gai CONSULTANTS, INC.

FIGURE 4

APPENDIX F

GEOLOGY

Geology

Lake Greeley Dam is located in the glaciated Low Plateaus section of the Appalachian Plateaus physiographic province of eastern Pennsylvania. In this area, the Appalachian Plateaus province is characterized topographically by flat-topped, hummocky hills formed as a result of glaciation and subsequent stream dissection of nearly flat-lying strata. The Devonian age sedimentary rock strata in Pike County regionally strike N35°E and dip gently to the northwest. The Delaware River is the major drainage basin in the area. Major tributary streams intersect the Delaware River at right angles; whereas, smaller streams display a slightly more random tributary pattern. Both major and minor tributary stream systems are joint controlled and exhibit modified rectangular and trellis-type drainage patterns.

Structurally, the area containing Pike County lies on the south flank of a broad, asymmetrical synclinorium that plunges to the southwest. Superimposed on this broad structural basin are numerous anticlinal and synclinal folds characterized by planar limbs and narrow hinges. Due to prior glaciation, low relief and surficial soil cover, fold axes are difficult to trace.

The sedimentary rock sequences in the vicinity of the dam and reservoir are probably members of the Susquehanna Group of Upper Devonian age (see Geology Map). The sedimentological changes observed in the Catskill Formation indicate that the rate of sedimentation exceeded the rate of basin subsidence resulting in a facies change from marine to non-marine strata. On the accompanying geology map the delineation between the Middle and Upper Devonian age sedimentary rock sequences represents the Allegheny Front which separates the Valley and Ridge physiographic province from the Appalachian Plateaus physiographic province.

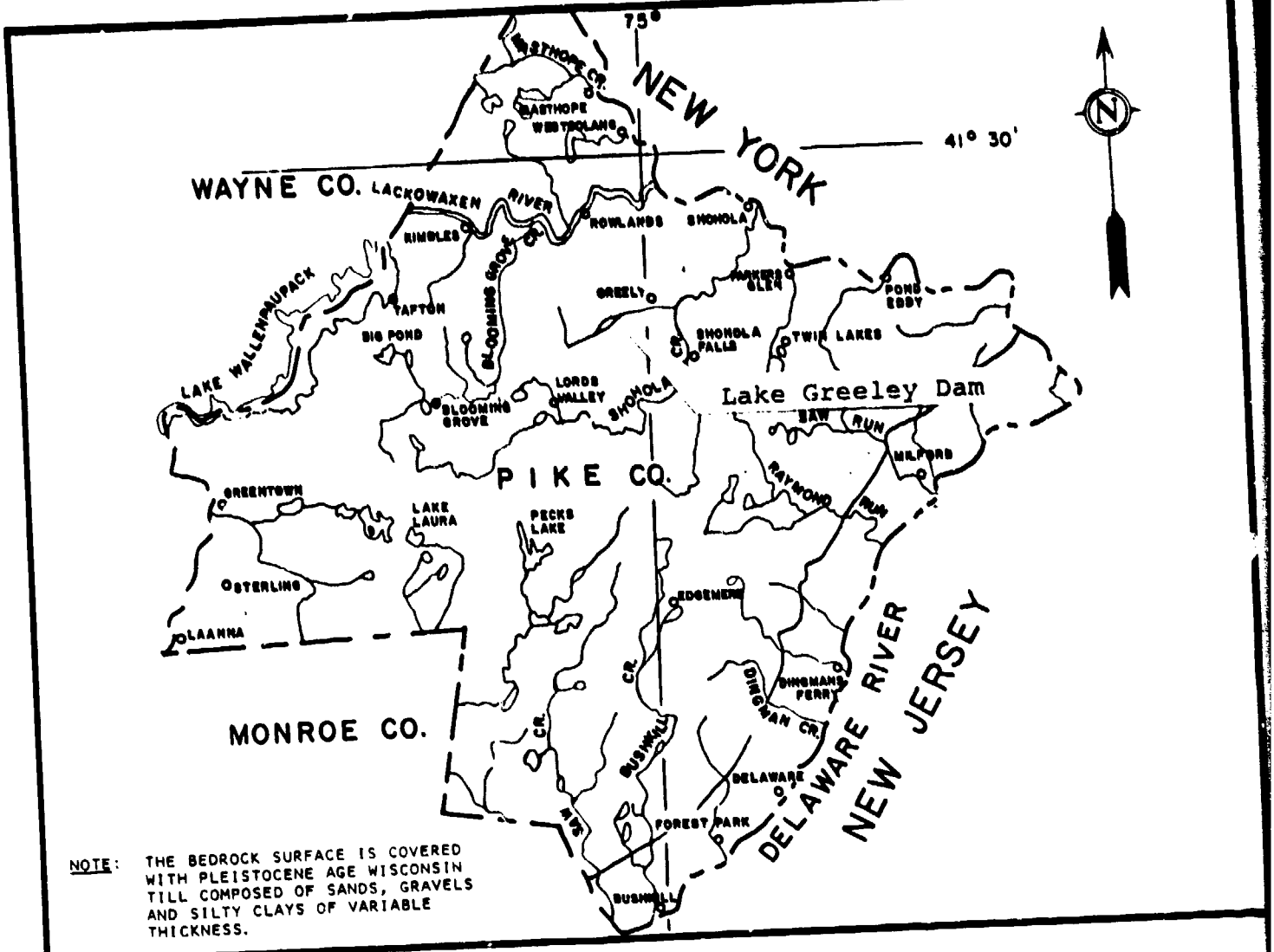
Approximately half of Pike County, including the dam site, is covered by a blanket of Wisconsin age (most recent) glacial drift which, based on the degree of weathering, was probably deposited during the Woodfordian stage. Valley bottoms are typically covered by recent alluvium and Woodfordian outwash of variable thickness, but typically less than 10 feet. These deposits are characteristically unconsolidated stratified sand and gravel, usually with more gravel than sand and some small boulders. The direction of the Wisconsin ice advance was from the northeast over the Catskill Mountains and from the north over the Appalachian Plateau. The terminal moraine resulting from the southern most advance of the Wisconsin ice sheet in this area is located in the southern portion of Monroe County which borders Pike County to the South.

References:

1. Fletcher, F. W., Woodrow, D. L., "Geology and Economic Resources of the Pennsylvania Portion of the Milford and Port Jervis 15 minute U.S.G.S. Topographic Quadrangles," Pennsylvania Geological Survey, Fourth Series, Harrisburg, Atlas 223, 1970.

2. Sevon, W. D., Berg, T. M., "Geology and Mineral Resources of the Skytop Quadrangle, Monroe and Pike Counties, Pennsylvania", Pennsylvania Geological Survey, Fourth Series, Harrisburg, Atlas 214A., 1978.

3. Sevon, W., Personal Communication, Commonwealth of Pennsylvania Department of Environmental Resources, Harrisburg, December 3, 1980.



NOTE: THE BEDROCK SURFACE IS COVERED WITH PLEISTOCENE AGE WISCONSIN TILL COMPOSED OF SANDS, GRAVELS AND SILTY CLAYS OF VARIABLE THICKNESS.

LEGEND

UPPER DEVONIAN

SUSQUEHANNA GROUP

Catskill Formation - *Shohola Member interbedded 5- to 25-foot thick units of greenish-gray and grayish-red very fine to medium-grained sandstone and sandy shale and lesser medium-gray to medium-dark-gray sandstone and shale. Sandstones are predominantly low-rank graywackes. Beds are thin to very thick and most have simple or planar sets of small- to medium-scale, generally low-angle cross stratification. Contacts with shale units are abruptly disconformable to gradational. Sandstones are poorly cleaved. Shale is thinly laminated and well cleaved. Mud cracks, convolute bedding, and sole marks are present near contacts with sandstone units. Member is more than 2,000 feet thick. Lower contact is gradational and is placed at top of highest red bed of the underlying Analomink. Analomink Red Shale Member, medium-grayish red silty, micaceous, finely laminated well-cleaved shale containing thin beds of brownish-gray sandy siltstone and silty very fine grained sandstone. Unit is the "first red" going up section in Upper Devonian sequence. Member is about 100 feet thick. Lower contact is gradational and is placed at the base of lowest red bed. Delaware River Flags Member, grayish-green, micaceous, laminated sandstone and lesser interbedded sandy shale. Beds range from a few inches to as much as 4 feet thick. Sandstones are low-rank graywackes and contain no marine fossils. Member is about 300 feet thick. Lower contact is gradational.*

MIDDLE DEVONIAN

HAMILTON GROUP

Mahantango Formation - *Upper member medium-dark-gray, fairly coarse grained, thin-bedded siltstone and silty shale; member is about 700 feet thick and is separated from lower member by the "Centerfield Reef," a calcareous siltstone biostrome containing abundant horn corals. The Centerfield is about 25 feet thick, lower member, virtually same lithology as upper member. Unit is about 1,100 feet thick. Lower contact is gradational.*

Marcellus Shale - *Dark-gray, evenly laminated, silty clay shale and clayey silt shale. Unit commonly contains very hard limy concretions and is well cleaved; bedding is generally obscured. Member is about 75-feet thick. Lower contact is gradational.*

SCALE

0 6 12 18 MILES

REFERENCE: GEOLOGIC MAP OF NORTHEASTERN PENNSYLVANIA. COMPILED BY GEO. W. STOSE AND O.A. LJUNGSTEDT COMMONWEALTH OF PENNSYLVANIA DEPT. OF INTERNAL AFFAIRS DATED 1932, SCALE 1" = 6 MILES.

GEOLOGY MAP

GAI CONSULTANTS, INC